*THE*

# AMERICAN ORTHOPTIC JOURNAL

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1952

VOLUME 2

Dedicated to Dr. Walter B. Lancaster

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*Official Organ of*

AMERICAN ASSOCIATION

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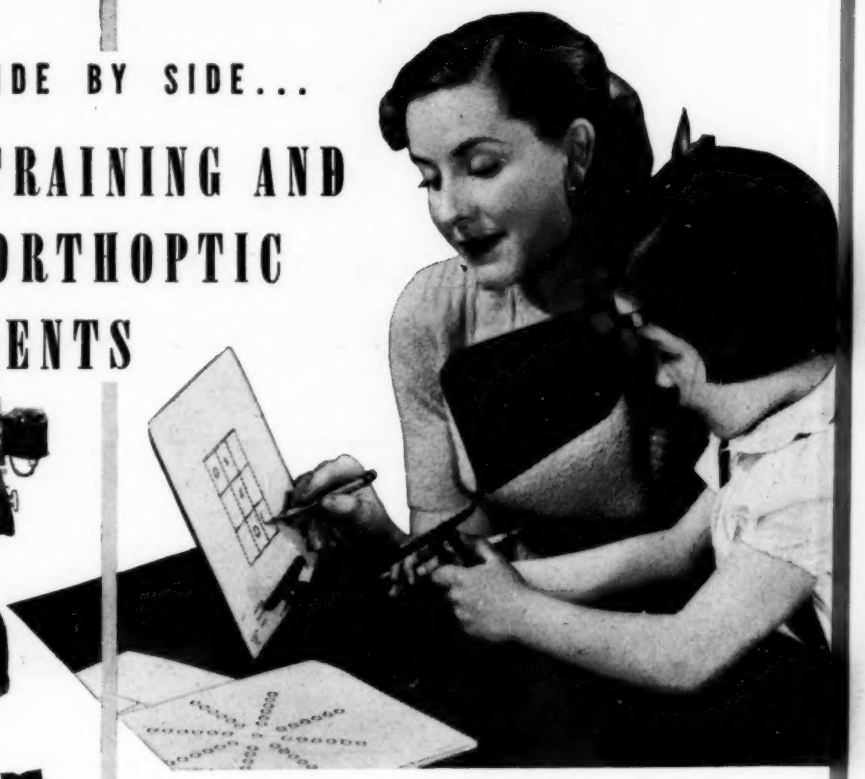

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PRINTED IN OMAHA, NEBRASKA
BY
DOUGLAS PRINTING COMPANY

PRINTED IN U.S.A.

# PHYSIOLOGY

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BEVERLY HILLS, CALIF.

IN this symposium my part would seem to be to answer the question: "What physiologic factors must the examiner keep in mind when confronted with a patient with intermittent exotropia?" The title "Intermittent Exotropia" implies a certain limitation in the classification of exotropia, but from an etiologic viewpoint the underlying causative factors are probably the same for constant exotropia and for intermittent exotropia.

For example, if movement of the two eyes is restricted by orbital pathology, the position of the eyes could conceivably be exotropic in some positions of gaze and esotropic in others. With lesions involving the posterior part of the median longitudinal fasciculus, there may be normal convergence and yet paralysis of adduction of either or both medial rectus muscles leading to an apparent intermittent exotropia. In myasthenia gravis it is commonly noted that the position of the eyes on cursory examination is one of parallelism, but involvement of the medial rectus may result in exotropia when the patient directs his gaze in a field requiring the use of that muscle. These far-fetched anatomic and innervational causes of intermittent exotropia are cited to show that your program chairman, in choosing the title, realized that the problem of divergence excess, convergence insufficiency, or both, is much more involved than would be implied had he named in the title these entities commonly cited as the basis for intermittent exotropia.

The criteria of these clinical entities are well known and need not be listed. The etiologic factors involved, usually cited in textbooks, need only enumeration:

1. *Anatomic factors:* (a) variations in the lateral positions of the orbits and asymmetry of the orbits, (b) shallowness of the orbits as seen in faulty development of the skull leading to hyperteleorism, (c) proptosis and enlargement of the globes embarrassing adduction and convergence, and (d) fascial and muscular anomalies of the extraocular musculature.

2. *Innervational factors:* (a) deficient convergence impulses as a consequence of myopia, (b) reduced visual acuity from refractive error or other cause, particularly if uniocular, (c) inattention in fatigue, (d) sleep and deep anesthesia, (e) low pitch of convergence tone and high pitch of divergence tone, and finally (f) faulty development of fusional binocular reflexes as a result of any of the above-mentioned abnormalities with consequent faulty sensory adaptation, such as suppression and anomalous retinal correspondence. In our treatment of such cases we attempt to correct the abnormal sensory adaptations first and thus effect a cure. One must then postulate that, theoretically, these could have been the primary causes of the divergence.

It is generally assumed that there is a center for convergence and that this is located in Perlia's nucleus in the third

Read at the annual Joint Meeting of the American Orthoptic Council and the American Association of Orthoptic Technicians, Oct. 16, 1951, Chicago, Ill.

nerve nucleus complex. Lesions affecting this directly, or afferent impulses to it, could readily result in convergence excess or convergence insufficiency. Many authors assume the existence of a similar center for divergence and locate it near the sixth nerve nucleus because the clinical entity of divergence insufficiency or paralysis has resulted from lesions demonstrated to be in this area.[7] Other authors deny the existence of such a center because no area in the brain has been found which, when stimulated with an electrode, produces divergence. It is believed by some that divergence is brought about passively by the normal elasticity of the divergent orbital structures plus the active inhibition of convergence—an explanation which makes divergence comparable with the passive relaxation of accommodation. If the criterion for the existence of a center is an accumulation of cells which when stimulated produces a complicated coordinated physiologic response, then even the center for convergence has been found wanting.[11]

The factors listed as having a possible bearing upon the etiology of intermittent exotropia may form a general pattern of consistency in any series of cases, but the exceptions are such that these general causes do not give a satisfactory explanation for the whole mechanism involved. For example, it is not rare to see widely separated eyes with no significant refractive error, showing orthophoria, normal convergence, and no evidence of excessive divergence. Exophthalmos does not always lead to exophoria and convergence weakness. Again, we see congenital unilateral lesions of the macula in eyes showing apparent orthophoria. We see no incidence of myopia in divergence excess that is consistent with the theory of deficient convergence impulses as a consequence of the myopia. Cass[1] reported a series of 88 patients with exotropia; of those cases due to divergence excess, 71.5 per cent were emmetropic, none were myopic, and 14.5 per cent were hypermetropic; of those due to convergence insufficiency, 45 per cent were emmetropic, 17 per cent were myopic, and 34 per cent were hypermetropic.

The position of the eyes in sleep, although generally believed to be divergent, is quite variable, judging from reported observations.[8] Under anesthesia the position varies with the depth and type of anesthesia. With pentothal sodium the eyes tend to be forcibly elevated and divergent. In anoxemia they tend to be convergent.

Haessler[5] has shown that the phoria position of the eyes, whether divergent or convergent, is unrelated to the degree and facility of divergence and convergence.

Obviously, the cause of intermittent exotropia is not known and it remains for me to discuss certain physiologic concepts and some personal observations that may have a bearing on the problem.

Anatomically the alignment of the eyes in the orbits is such than an exotropic position would exist if other factors were absent. The orbit and the muscle cone make an angle of approximately 25 degrees with the sagittal plane of the head. In many ungulates the eyes assume a position of divergence at all times and the field of vision is thereby enlarged so that the animal is better protected from an approaching enemy. In man, whose eyes show progressively discriminatory visual acuity from the periphery of the retina to the fovea, the eyes instead of being divergent are convergent at all times when both foveas are fixing the same object. Complicated innervational reflexes give proper tone to the eye muscles, altering and maintaining their position on the object of attention. The basic inborn compensatory fixation reflexes or gravitational

reflexes, whose afferent arc is the proprioceptive impulses from the neck and the labyrinth, constantly readjust tone, yoke the eyes together, and hold them in the primary position as the head or body is moved. In the decerebrate animal these basic gravitational impulses move the eyes opposite to head movement in a mechanical, doll-like fashion. Their tone is altered for purposes of better coordination by the cerebellum. It is also affected by more basic impulses as noise and pain, causing the eyes to turn in the direction of such stimuli. Allied with these postural gravitational reflexes are the retinal orientation fixation reflexes that also affect conjugate movement of the eyes and fixation. These reflexes require sight. The sensory organ is the retina and the afferent arc, the retinal fibers. We speak of the reflex of "regard" as causing the eyes to turn toward a stimulus in the periphery of the retina; the "following" reflex as causing the eyes to follow a moving object; and the "fixation" reflexes. The centers for these involuntary and unlearned reflexes are in the occipital lobe. Lesions around the superior colliculus may paralyze voluntary movement of the eyes but they will still move in response to the "following" reflex. With such lesions the eyes cannot shift fixation from one object to another voluntarily, yet they may be made to turn in any direction by either moving the fixation object slowly or rotating the head passively while fixation is being maintained; it is as though the eyes were locked in a state of obligatory fixation. An inhibitory reflex from the cortex is required to suspend the prevailing fixation long enough to allow it to shift in response to a visual stimulus impinging upon a peripheral portion of the retina. Thus the postural gravitational reflexes and the orientation retinal reflexes serve to keep the eyes conjugately fixed in respect to gravitation and orientation points respectively. Vergence reflexes develop later in the phylogenetic scale and correct for orientation from distance to near. They produce both horizontal convergence and divergence, and vertical and cyclovergent movements. These vergence reflexes probably have both innate and conditioned (learned) aspects. Once the object of attention is fixated, additional minute movements of fixation constantly move the eyes about the point of fixation for searching and studying the object, moving the retinas so that one receptor and then another is stimulated as receptors become fatigued and refractory.

Next in development we have the binocular fusional reflexes bringing about a different type of convergent, divergent, or vertical binocular adjustment in response to stimuli from disparate points on the retina that are being visualized. The movements are executed slowly and there is a persistence of the induced position for some time after the stimulus has been removed. These achieve the binocular stereoscopic image and, of themselves, have a steadying effect on eye movements. They are involuntary and doubtless, in part, are conditioned or learned reflexes. The facility with which these reflexes can be learned varies from individual to individual, and the so-called "absence of a fusion center," all other things being equal, could simply be a lack of ability of the nervous mechanism to be conditioned. Finally the voluntary reflexes, centered in the frontal lobes of the cerebral cortex, exert a dominant tone on the underlying basic reflexes, inhibiting or stimulating so that the eyes may be moved in response to volition.

From a physiologic standpoint, when we speak of a center for this or that activity we mean simply that there is a localized area in the brain which, on stimulation, produces a certain complicated

reflex response. Being complicated, it necessarily is the station wherein many afferent or efferent nerve fibers have converged to a point at which a single stimulus can produce the complicated response. There are many activities that do not require such a convergence of afferent or efferent impulses and consequently would have no so-called center, and yet their physiologic activity would not suffer.

In other words, there can be divergence tone without postulating a divergence center. Such an active divergence tone is necessary in fusional movements to overcome latent esophoria, as Bielschowsky has stated.

Nervous impulses are then constantly bombarding the motor nuclei of the eye muscles and, in turn, through these, the eye muscles themselves, with varying tone of these muscles in the living eye resulting. It becomes impossible to stimulate a "position of rest" of the eyes except in ophthalmoplegia, curare poisoning, or death. The question then arises, do the eyes assume the position of the orbits, namely 25 degrees of divergence, in death? This has been assumed and it has been disputed,[9] and as far as I know, no one has determined the orbital axes and position of the eyes just before and just after death. It has also been impractical to correlate the heterophoria existing during life with the position of the eyes after death. Compilation of such measurements would enable us to understand better the effect of divergence of the orbits on divergent strabismus. Relating orbital measurements and racial types to phorias and strabismus would be a most interesting study. Flanagan, Hill and Kvernland,[4] taking action currents off the eye muscles, failed to record activity during the resting state and postulated a toneless state of the eye muscles in the living eye. In view of the concept of innervational tone just described, this work bears repeating with multiple electrodes, to pick up tone impulses. We should determine whether or not, in divergence excess, there is excess tone in the lateral recti as compared to the medial recti. If the resting muscle does not record action potentials, this cannot be determined, but here again is a field for investigation. Duke-Elder has shown, by recording action currents, that the ganglion cells in the retina reach a refractory state quickly in curarized animals. Does this mean that minimal vibration from extraocular muscle tone moved the electrode to a different cell, or in some way affects a cell that is unaffected when the muscles are completely paralyzed?

At one time Ludvigh and I[6] presented evidence that the usual criteria for proprioceptive senses were found wanting in the extraocular muscles. We also noted differences in anatomy and physiology between eye muscles and other muscles and explained their plastic tone, allowing for fine adjustments of movement, as compared to the tone of unstriated muscle. Since then proprioceptive sense organs have been found[2] and typical proprioceptive action currents have been recorded from eye muscles,[3] so that many of the concepts explaining visual phenomena on the basis of absence of proprioceptive sense may have to be altered.

As these fundamental problems are solved, our explanation of divergence may better explain all types of cases. I recently saw a man, 54 years of age, who presumably had normal eyes until he suddenly became aware of diplopia and showed a divergent strabismus of 45 degrees. He could converge momentarily and had normal retinal correspondence. We operated on this man four times, doing bilateral recessions of his lateral recti as well as bilateral resections of the medial recti, and succeeded in only partially correcting his exotropia. To say this man did not have divergent tone

and that divergence in this case was but a passive response to lack of convergence would be unreasonable. All ophthalmologists have seen cases of divergence that responded poorly to operative changes in the position of the globes, and they have seen other cases of equal degree overcorrected by the same procedures.

For diagnostic purposes I have injected novocain into extraocular muscles to partially or completely paralyze them, lessening the innervational tone of the muscles, and then observed the effect on the squint. One 26-year-old army sergeant had an external strabismus from childhood; it amounted to 35 prism diopters for distance and 10 to 15 prism diopters for near. Convergence could be fairly well maintained and he had what appeared to be binocular vision for near. He had normal retinal correspondence and simultaneous macular perception, but no fusion. There may have been a small central inhibitory scotoma in the left eye. The left lateral rectus was injected with novocain, paralyzing the muscle so that the eye could move only 4 prism diopters to the left. Even with this paresis there persisted approximately 2 prism diopters exotropia for distance in the primary position. On turning the eyes to the right, 10 prism diopters of exotropia persisted, without diplopia, whereas on turning the eyes to the left there was immediate esotropia and double vision. It is interesting that the exotropia persisted in the right field even though the medial rectus of the left eye was unopposed by the left lateral rectus. Ordinarily, on conjugate deviation to the right, the left lateral rectus would presumably be inhibited anyway, but by the injection we were certain of inhibition and still had excess tone of the external rectus of the right eye in conjugate deviation causing divergence.

We have all seen examples of marked exotropia when the patient is looking down, with relative orthophoria in the primary position or on looking up. I recently saw such a case, a 30-year-old woman with binocular vision and unlimited convergence and a pupillary distance of only 58 mm. She obviously had bilateral paresis of the inferior recti. She had always been aware of diplopia at times but it did not bother her. She volunteered that on going out into bright light she usually shut one eye. Her explanation of this was indefinite—the light was too bright, or perhaps the bright extra image was too difficult to inhibit. Operation revealed definitely abnormal adhesions, resembling fibromas, around the junctions of the inferior obliques and inferior recti on both sides. Freeing the adhesions and shortening the inferior and medial recti partially corrected the condition. I have seen similar cases, and I am quite sure that some exotropia cases are the result of bilateral weakness of the inferior recti or superior recti, lessening the adductive power of these muscles.

Another interesting case has been followed since 1931. At the age of 2 this little girl had an alternating esotropia for near. At the age of 7 her eyes were straight under cover, and then at times would turn in 50 prism diopters. Refraction revealed approximately 2.50 D. of hypermetropia in each eye. Visual acuity was normal. When she was 12 the patient had exophoria under cover for distance and near and a near point of convergence of 17.5 cm. Through orthoptic training she developed good amplitude of fusion, overcoming 50 prism diopters base out to 3 prism diopters base in. It was noticed that she fixed binocularly for distance and tended to shut her right eye for near work, but with plus 2 spheres for near work she had binocular vision for reading. At 18 she had definite exophoria for distance and esotropia for

near, but with her reading glasses she had binocular vision for near. At the age of 22, she had 20/20 vision in both eyes; refraction: O.D. — 0.37 cyl × 90 and O.S. + 0.25 — 0.37 × 70. With these glasses she had 6 diopters of exophoria for distance and esotropia for near. Unilateral accommodation showed 11 diopters accommodation for either eye, but binocular accommodation was less than 1 diopter. With a plus 1.75 add she had binocular vision for reading. Here then is a case which showed variable esotropia and exotropia because of insufficiency of binocular accommodation. The change in the patient's strabismus with age shows how absence of one link in the binocular reflex system can produce a variable type of strabismus, depending on anatomic and innervational factors.

Finally, I might call attention to a case of typical divergence excess in a girl of 25 showing normal vision without refractive error, normal convergence power for close work, and apparent binocular vision for close work with intermittent exotropia when looking in the distance. At times the eyes are straight and at other times one eye drifts out. On the synoptophore the patient showed a large facultative scotoma at the angle of squint, false projection between this area and the macula, and apparently little fusion. Many times she would project homonymously when the maculas were stimulated simultaneously, yet, when looking at the Snellen chart, she could hold her eyes together and fusional movements could be elicted by placing prisms in front of her eyes. The afterimage test showed both normal and abnormal retinal correspondence, the patient at times seeing a cross and at other times seeing the vertical or horizontal lines separately. Under certain circumstances, as in strong sunlight, the patient squinted one eye. Yet she showed marked inhibition of diplopia when tested with the amblyoscope. With a Maddox rod, looking intently at the light and the red line, and having been told their approximate distance from her, she showed only 5 or 6 prism diopters of exophoria with no evidence of suppression. Yet, when tested on the synoptophore she showed marked suppression. What does this mean? We get the impression that under certain circumstances of gaze and attention, normal binocular reflexes are operating and rapid cover test and Maddox cross elicit only a slight degree of exophoria. The binocular reflexes have locked the eyes together, so to speak, as in the normal individual. Yet, under other conditions of attention, such as when day-dreaming, or when the eyes are covered with certain instruments, or on prolonged occlusion, there is reversion to the more primitive type of vision, the two eyes acting as unrelated units.

We see a similar phenomenon produced experimentally in patients with cataracts, who have used one eye for some time, allowing the more cataractous eye to diverge. After both cataracts are removed and glasses are prescribed, there may be 20 to 30 prism diopters of divergence. With very little practice and training, binocular vision is achieved, and then when one measures the phorias in the usual manner one finds them reduced to the usual range, not the extreme degree manifest immediately after surgery.

This brings us to the question of sensory adaptation in intermittent exotropia. I am sure you are aware that there are all degrees of change, some cases showing normal retinal correspondence, fusion amplitudes and stereopsis when converging binocularly, yet when fixing monocularly, showing suppression at the angle of squint, with normal to false projection between this area and the macula, and sometimes inattention at the macula, similar to the inat-

tention used when looking into a monocular microscope. At other times the patient sees both macular images equally well and projects them to the right and left fields. Occasionally one finds a scotoma at the macula or there is alternate suppression, the patient seeing first the right and then the left image, interpreting the position of the images homonymously no matter where placed, there being no spatial relationship between right and left images. In some cases peripheral fusion seems normal but patients are unable to superimpose foveal images, one overlapping the other, moving about slightly without actual fusion taking place. Theoretically, the more abnormal the retinal correspondence the more difficult the case would be to treat, and yet it is surprising how this correspondence may appear to vary, depending on the test used to determine it. One is often misled into thinking a case is going to be difficult to correct, only to find it surprisingly easy after surgery. The most difficult cases to treat seem to be those associated with marked vertical imbalance, which cannot be explained as a function of divergence alone, those with complete paralysis of convergence, and those who anatomically show laterally placed eyes as judged by the position of the internal canthus farther forward than the external canthus.

Finally, since the anatomic factors are not consistent, since convergence and divergence seem to be independent of the phorias, since the refractive changes do not explain the problem, and since developmental factors resulting in faulty learning of binocular reflexes do not apply to intermittent exotropia where retinal correspondence is normal, I am inclined to agree with those who believe that convergence insufficiency is simply a lack of convergence tone which responds well to orthoptic treatment; that divergence excess is a reversion to an atavistic type of innervation of the eyes,[10] and that this alone or in combination with convergence insufficiency is best treated by both surgery and orthoptics.

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# DIAGNOSIS AND INCIDENCE

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WASHINGTON, D. C.

As an introduction to this paper, may I say that diagnosis of strabismus is primarily the province of the ophthalmologist; the treatment depends upon proper diagnosis. It is the privilege and responsibility of the ophthalmologist in referring cases for orthoptic treatment to make the diagnosis and recommend corrective measures.

Diagnosis is important to the orthoptic technician for the same reason that it is important to the ophthalmologist — that is, proper understanding of the deficiencies of each individual case, so that treatment may be undertaken in a direct manner with no time lost on unnecessary maneuvers. It was a lack of understanding of the results of diagnostic procedure which at first led technicians to promise miracles and ophthalmologists to expect them. This phase is past. We now have a good idea of what is possible and what is not, and we try to act upon that knowledge.

Comitant exotropia is divided into three classes, the convergence insufficiency type, the divergence excess type, and a combination of divergence excess and convergence insufficiency.

The convergence insufficiency cases are the easiest to understand and the most rewarding to treat orthoptically, but the divergence excess cases are by far the most interesting and challenging, even though in the majority of the cases the nonsurgical treatment is not directed toward a "cure" but is pointed toward preparing the patient to be able to get a more lasting result from surgery. This latter group, the divergence excess type of intermittent exotropias, is the group with which this paper is concerned.

The characteristics of divergence excess are as follows[2]:

1. Exophoria or exotropia is greater for distance than for near.
2. The deviation is intermittent, varying with visual attention, state of health, and position of fixation.
3. The near point of convergence is normal and the prism convergence is ample for near.
4. Prism divergence may be normal or excessive for near, while the measurements of prism divergence for distance are difficult because of frequent suppression.
5. Amblyopia of any degree is rare.
6. There is almost constant suppression at distance.
7. Normal retinal correspondence is present for near, while at times abnormal retinal correspondence can be demonstrated for distance, although usually suppression interferes or questionable correspondence is present.
8. The refractive error usually is not significant.
9. Visual confusion frequently is present.

The rest of this paper is an elaboration on these characteristics with their incidence, and an explanation of the tests which we use in determining or qualifying each.

Read at the annual Joint Meeting of the American Orthoptic Council and the American Association of Orthoptic Technicians, Oct. 16, 1951, Chicago, Ill.

In studying the incidence of the various factors in intermittent exotropia, I took the first 1,000 cases of squint in our files. Of these, 210 or 21 per cent were cases of divergent strabismus. Of these 210, there were 76 cases of divergence excess and 50 cases of divergence excess combined with convergence insufficiency. My figures for incidence will not always agree with these totals, since in many cases the patients were too young for certain tests.

*Deviation*

The patient may have either exophoria or exotropia at 20 feet and be exophoric, exotropic, or orthophoric at 13 inches, but his measurements will be less for near than for distance. He may even vary between exophoria and exotropia within one period of examination. He may be obviously exotropic while playing about the office or sitting quietly while the history is being taken, but when examined, the eyes may be straight at distance and near until covered. This variability of deviation may be determined roughly by casual observation and verified by actual measurement.

In the divergence excess cases the average deviation for 20 feet was 29 prism diopters, and for near, 9 prism diopters, or a difference of 20 prism diopters between distance and near. In the combined divergence excess and convergence insufficiency cases, the average deviation for distance was 19 prism diopters, and for near, 13 prism diopters, or an average difference of 6 prism diopters.

There are many methods of measuring the deviation, but we usually use one of the following:

a. The *corneal reflex* test of Hirschberg is useful in very small children and in patients with a high degree of amblyopia and poor fixation. A light is held at about 13 inches from the patient's eyes. The corneal reflex will be centered in the fixing eye and decentered in the nonfixing eye. Allowing for angle kappa, the measurement can be approximated in this test by estimating six or seven arc degrees of deviation for each millimeter the reflex is removed from the center of the cornea of the nonfixing eye.

b. The *prism reflex* of Krimsky gives a similar result. The light is presented at about 13 inches from the patient's eyes and prisms of increasing strength are held base in before the fixing eye until the corneal reflex is centered on the nonfixing eye. The strength of the prism needed to center the reflex is approximately the angle of exotropia, although here again the angle kappa must be considered.

c. The *prism and cover* test is the most accurate for measuring a deviation. The patient fixes a light at distance or near, and prisms of increasing strength are placed base in before the eyes, the examiner covering the eyes alternately until all movement is stopped. The amount of prism necessary to stop fixation movement of the eyes is the measurement of the exotropia.

*Intermittency*

Intermittency is that condition which exists when the squint alternates from no gross deviation to obvious exotropia from one minute to the next. The occurrence of this characteristic is nearly always obtainable from the history of the case and may be elicited by careful questioning of the parents. It is usually noticeable during the examination.

*Near Point of Convergence*

Of the 76 cases of divergence excess, all had good convergence. If not, they would have been classified as divergence excess combined with convergence insufficiency.

The test for the near point of convergence is done by moving a small fixation object toward the nose and measuring the distance at which fusion breaks. A pencil point may be used for adults, but we find that this does not interest small children and they will do much better with a small picture or some other object of interest. We use a white-headed pin on which there have been placed two small black dots. This pin is stuck into the eraser of a pencil, which is rotated as it approaches the nose, so that first *one*, then *two*, then *no* dots are visible to the patient. The child's interest is held because he is counting the dots as they appear.

*Prism Convergence and Divergence*

Prism convergence and divergence are difficult to measure at distance in most cases because of suppression and lack of fusion. For near, the prism convergence is good and the prism divergence is from normal to excessive.

We use loose prisms, the prism bar, and the rotary prism, but the rotary prism has proved best for our purpose since it gives a smoother transition in increasing the prism strength. The patient has a greater amplitude if he does not have to regain fusion each time the prism is increased.

A small light or a black dot on a white background is fixated at 13 inches, and the prism is rotated base in or base out until fusion breaks. This is the break point. The prism strength is then decreased until the patient is able to regain fusion. This is the recovery point.

The tests for convergence and divergence should not immediately follow each other since there is a definite lag of convergence following divergence, and vice versa.

*Amblyopia*

Amblyopia of more than slight amount is very rare in divergence excess because of the intermittency of the squint. Frequently, however, the visual acuity in the nonfixing eye cannot be improved to better than 20/30. For the purpose of this paper, a difference in visual acuity between the two eyes of more than one line on the Snellen vision chart was considered a significant amount of amblyopia.

In the patients who were too young to allow measurement of visual acuity, we accepted fixation readings; when central fixation is not good, the eye is considered amblyopic. Of the 126 patients in the series, only 11 were amblyopic to any significant degree, 8 as a result of anisometropia, 1 because of a cataract, and 1 because of macular degeneration, leaving only 1 patient in 126 that could be said to have marked amblyopia from disuse.

*Suppression*

Almost invariably suppression is found at 20 feet in intermittent exotropia, but seldom at 13 inches. In this series, there was either monocular or alternate suppression in every case when the eyes were divergent. While suppression fields were done on only a few cases, suppression areas were probably present both in the macula of the deviating eye and in the retinal area having a common visual direction with the fovea of the fixating eye.

The tests for suppression which we use most commonly are:

a. *Major amblyoscope:* Similar targets with check marks are aligned before the foveas of the two eyes. The check mark before the suppressing eye will disappear, and at times the whole target will disappear. Upon moving the arms of the machine to and fro, the target before the suppressing eye will appear first on one side then on the other side of the target before the fixing eye. The extent of the disappearance is the extent of the area of suppression.

b. *Lancaster red-green:* This test is also used to map out the area of suppression. The patient is seated 2 meters from a gridded screen. The patient is wearing red-green spectacles and a red light is projected at the center of the screen for him to fix. The green light is then moved back and forth across the red light and is reported by the patient as disappearing as it approaches the red light. This is a more accurate way of mapping the suppression area than by use of the major amblyoscope, since the light can be easily moved and the area measured in all meridians.

c. *Worth 4-dot:* This test may be done at 20 feet or at 13 inches. A pair of red-green spectacles is placed over the patient's eyes, the red lens over the right eye. The fixation object consists of four lights, two green, one red and one white. If the patient is suppressing the right eye behind the red lens, he sees three green lights; if he is suppressing the left eye behind the green lens, he sees two red lights; if he is not suppressing and is divergent, he will see five lights—two red and three green; if he is fusing, he sees four lights. This test may be varied by covering any of the lights, and *should* be varied because it is a fixed test and the patient's desire to please plus his good memory may elicit false answers.

*Retinal Correspondence*

In intermittent exotropia, when tested at 20 feet, normal retinal correspondence, abnormal retinal correspondence, or confused retinal correspondence may be present because of the nature of the squint. When tested at 13 inches, normal retinal correspondence is usually present.

If a test approximates the conditions of everyday use, the response will show the manner in which the patient uses his eyes for casual seeing. If the test is not related to the conditions of everyday usage, the patient is more likely to demonstrate his innate retinal correspondence. Thus, as Dr. Burian[1] has stated:

> If a patient responds in all tests with anomalous correspondence, we can assume that his anomalous correspondence is very deeply rooted. If he responds with an anomalous correspondence in certain tests but not in others, we can assume that the anomalous correspondence is only more or less superficially established.

The afterimage test bears no relation to the habitual use of the eyes and so will usually demonstrate the innate normal correspondence. The major amblyoscope and the red-glass tests more nearly approximate the everyday usage of the eyes. They are, therefore, more likely to show any tendency toward abnormal retinal correspondence which the patient may have developed.

In the 90 patients whose retinal correspondence could be determined, the findings were:

| NO. OF CASES | PERCENTAGE OF N.R.C. |
|---|---|
| *For Distance* | |
| 58 | 64 |
| 5 | 6 |
| 27 | 30 |
| *For Near* | |
| 87 | 97 |
| 3 | 3 |

Retinal correspondence is tested in one or all of three ways.

a. *Major amblyoscope:* Dissimilar targets are placed in the major amblyoscope, for instance, a lion before one eye and a cage before the other. The patient is asked to set the arms of the machine so that the lion appears to be in the cage. He may do one of two things. He may say that the lion is in the cage, or that the lion disappears as it passes the cage. This is the *subjective* measurement of his alignment, the angle at which *he thinks* his eyes are aligned. His eyes are then alter-

nately covered, and if there is no shift, he is using the fovea of each eye in conjunction with the other. If there is a shift, the operator moves the arms of the instrument until there is no shift on alternate cover and records this as his *objective* angle. The difference between the subjective angle and the objective angle is called the angle of anomaly. If the angle of anomaly is zero, that is, if the subjective and objective angles are the same, normal retinal correspondence is present. If there is an angle of anomaly of more than 5 diopters, that is, if there is a difference of more than 5 diopters between the subjective and the objective angles, there is probably an abnormal retinal correspondence. If the patient has normal retinal correspondence, then second and third grade targets are used to test his fusion, stereopsis, and amplitudes.

This same test should be done for near by placing — 3.00 lenses in the eye pieces of the instrument. I mention this because while many cases of divergence excess will have abnormal retinal correspondence or complete suppression of the image at distance, they will have normal retinal correspondence with good third degree fusion at near.

b. *Afterimage test of Hering:* A lighted filament is presented horizontally before one eye for 30 seconds while the other eye is covered. The filament is then presented vertically before the second eye for 30 seconds while the first eye is covered. The patient is then instructed to close his eyes and describe or draw the afterimage which he sees. If the horizontal and vertical lines appear in the form of a *cross,* there is normal retinal correspondence; if in any other form, there is abnormal retinal correspondence.

c. *Red glass:* The patient looks at a light with the red glass over one eye. The resulting diplopia is measured, and the measurement corresponds to the subjective angle. If this angle equals that of the prism and cover test, there is normal retinal correspondence. Quite often, especially in intermittent exotropia, there is monocular or alternating suppression at distance. This may usually be overcome by placing before one eye a prism base up or base down of sufficient strength to take the image out of the area of suppression. Base out or base in prisms are then used until the higher image is directly above the lower one. The same result may be obtained by using a base in or base out prism before one eye to approximate the angle of squint. If, then, the images are not approximately together, the patient has an abnormal retinal correspondence.

d. *Lancaster red-green:* The patient is placed 2 meters from the gridded screen and is given red-green spectacles. The operator throws a red light on the screen and the patient is asked to superimpose the green light which he is holding. If the angle between the two lights corresponds to his angle of squint, he has normal retinal correspondence; if not, he has abnormal retinal correspondence.

*Refractive Error*

This part of the diagnosis does not fall within the province of the orthoptic technician, so I shall not elaborate on the technics of refracting.

Cycloplegic refraction was not done on all patients, but of the 114 which were refracted the cycloplegic acceptance was as follows:

| CYCLOPLEGIC ACCEPTANCE | NO. OF CASES | PERCENTAGE |
|---|---|---|
| Within normal limits (Emmetropia to + 1.50S) | 65 | 57 |
| Hypermetropia of 2 diopters or more | 34 | 30 |
| Myopia of any degree | 15 | 13 |

From this we may judge that refractive error is not too significant and that myopia probably is not a significant etiologic factor in these cases.

*Visual Confusion*

There are many kinds of visual confusion: closing one eye in the bright light, rubbing one eye, diplopia, annoyance, photophobia.[3] These symptoms, which suggest an incomplete awareness of two eyes, may nearly always be elicited while taking the history.

There was a history of visual confusion in 77 or 61 per cent of the patients examined.

*Age of Onset*

The average age of onset of divergence excess was 1.8 years; for divergence excess combined with convergence insufficiency, it was 1.9 years, whereas the average duration of the squint before the first examination was 2.8 years for the divergence excess types and 4.5 years in the combined types. This would seem to suggest that the factor influencing the development of secondary convergence insufficiency is duration of squint before treatment rather than early age of onset. This is borne out by the fact that in the large majority of patients seen in the first year after onset, there was good convergence, but by the time they had reached the age of readiness for orthoptics, a convergence insufficiency had developed.

SUMMARY

In this presentation I have attempted to show that in intermittent exotropia (1) the divergence is greater at distance than at near, (2) suppression and retinal correspondence vary with the deviation and (3) the onset of intermittent exotropia is early, while the secondary convergence insufficiency increases with age.

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*Symposium: Intermittent Exotropia*

# TREATMENT

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The treatment of strabismus is ultimately to give a straight position of rest to the eyes. This may be accomplished by strengthening fusion and improving amplitudes and/or changing the position of rest of the eyes.

In our discussion we will use the term "intermittent exotropia" to include only the following two types of comitant exotropia: the pure "divergence excess" type and mixed divergence excess with secondary convergence insufficiency.

The treatment of the pure divergence excess type of intermittent exotropia includes (a) optical treatment and near work stimulation, (b) orthoptics, and (c) surgical treatment.

In the more or less "pure" case, where there is no evidence of convergence insufficiency, treatment depends upon the age of the patient and upon how conspicuous the deviation is. When the deviation is very occasional in a patient under the age of 5 and is cosmetically satisfactory, I advise observation of its frequency by the parents, who report to me at the yearly examinations, and delay actual treatment as far as orthoptics and surgery are concerned. Orthoptics, in my hands, is not usually worth while before the age of 5 and is even better after 6. If convergence insufficiency appears and progresses, treatment is indicated at any age. Usually a divergence excess measuring 20 prism diopters at 20 feet will require surgery.

Read at the annual Joint Meeting of the American Orthoptic Council and the American Association of Orthoptic Technicians, Oct. 16, 1951, Chicago, Ill.

## DIVERGENCE EXCESS

### *Optical Treatment*

Moderate or small hypermetropic refractive errors, which are the most common, should not be corrected, but myopia should be corrected fully or even overcorrected. Overcorrection stimulates the accommodation and prevents or delays secondary convergence insufficiency. Overcorrection is very useful in young children but may cause severe asthenopic symptoms in young adults. An interesting recent example of its effect in adults occurred in the case of a 32-year-old orthoptic technician who was able to control fairly well 20 diopters of exotropia with the following: R - 2.50 + 0.75 × 110; L - 2.25 + 1.00 × 70. She complained of pain in her right eye. Her refractive error under homatropine was: R + 0.50 + 0.50 × 75; L + 0.25 + 0.75 × 60.

In considering the use of glasses, many of the youngsters who have small hypermetropic errors or are emmetropic are potential myopes. The parents should be made aware of this probability and of the hereditary nature of the refractive error.

The incorporation of prism for an associated vertical anomaly, for distance only, is not of value in these cases since the absence of the vertical deviation for near may lead to prism-induced symptoms.

*The use of dark glasses in bright light for the relief of confusion.* In such cases of visual confusion the child closes one eye in bright light because the light seems to stimulate the suppression of

fusion and thus permits divergence (Costenbader, et al.[2]). He rubs one eye frequently, has an attitude of annoyance when the eye diverges and, at times, an actual diplopia when manifest divergence is present. Dark glasses thus add to comfort and protect against divergence.

*Near work stimulation.* Near work of a detailed nature should be encouraged because of the increased attention which stimulates convergence. This aims at preventing secondary convergence insufficiency.

*Orthoptics*

In cases of the divergence excess type of comitant exotropia, orthoptics (both preoperative and postoperative) should aim at overcoming suppression, since this is probably the sequel to diplopia at the onset of the neuromuscular anomaly. The suppression is eliminated here by teaching the awareness of diplopia. Let me simply mention (1) the use of the red glass and/or vertical prisms to produce crossed diplopia at 20 feet, at first in the dark, then in the light, (2) physiologic diplopia and framing of objects at distance, and (3) the use of the stereoscope and major amblyoscope for the stimulation of fusion and amplitude at 20 feet. Convergence exercises may be useful when secondary convergence insufficiency is present, but in the pure divergence excess case, I have found the value of orthoptic instrumentation to be limited to overcoming suppression and increasing fusional amplitudes.

*Surgery*

The ultimate treatment of the divergence excess type of strabismus, whether or not the awareness of diplopia has been learned, is usually surgery. The usual procedure is recession of one or, more usually, both lateral recti. However, if there is normal muscle balance for near and a deviation only for distance, a convergent strabismus for near may result. In such a case with normal muscle balance for near, recession of the lateral rectus muscles must be associated with a smaller *recession* of one or both medial rectus muscles. "Pure" cases of divergence excess are not frequent and most surgical cases fall into the mixed divergence excess-convergence insufficiency group, the surgical treatment of which will be discussed below.

### DIVERGENCE EXCESS AND SECONDARY CONVERGENCE INSUFFICIENCY

As in the cases of divergence excess, the treatment of the mixed cases may be considered under the following headings: (a) optical treatment and near work stimulation, (b) orthoptics, and (c) surgical treatment.

*Optical Treatment and Near Work Stimulation*

The refractive errors should be corrected in the same manner described for divergence excess. Near work stimulation should be encouraged and dark glasses used in bright sunlight.

In youngsters under 5 years of age in whom there is progressive secondary convergence insufficiency, early surgery is definitely indicated and should be done as soon as it is evident that the condition is progressing.

*Orthoptics in Patients Over 5 Years of Age*

In mixed cases, in addition to the methods described to teach awareness of diplopia, orthoptics should be used to increase fusional amplitudes, eliminate suppression, and improve convergence.

The convergence exercises may include simple convergence exercises such as those done with the finger or pencil, or other more accommodation-stimulat-

ing methods such as bringing small objects up to the nose, prism convergence exercises, use of the stereoscope and slides, the major amblyoscope, and possibly the rotoscope.

*Surgical Treatment*

The type of surgical correction in these cases depends on one's experience. Burian[1] feels that it is not particularly important whether one does a recession of one muscle or a resection of the other so long as an intelligent approach to the deviation is maintained. Surgery does not change the innervational defect, only the mechanical position of the eye. Costenbader prefers bilateral surgery, resecting the medial recti in cases where there is secondary convergence insufficiency and doing a recession of the lateral recti where there is a pure "divergence excess." I prefer recession and resection on one eye in the mixed cases, largely because it permits better evaluation of the amount of residual correction when both eyes are to be attacked.

The surgery is done on the more frequently deviating eye if the deviation is under 50 prism diopters. If over 50 prism diopters, I prefer to do a 4 or 5 mm. recession of the lateral rectus and an 8 mm. resection of the medial rectus of the more frequently deviating eye and then remeasure after one month and do the remainder on the other eye. In instances of very marked divergence of over 45 arc degrees, one must use a larger recession of the lateral rectus up to 7 mm. In exceptional cases it may be necessary after maximal recessions and resections on both eyes to do a complete tenotony of one lateral rectus to obtain the desired result. I cover only the operated eye for a period of three days. A child thus awakens from anesthesia without the panic associated with inability to see, as when both eyes are covered. In cases where both lateral rectus muscles are recessed, only one eye is bandaged in the same manner.

It should be kept in mind that the measurement of the deviation in intermittent exotropia is often not the actual total latent deviation present. I have found it important in using the cover test with these cases to do the alternate covering slowly and to be sure that the deviation first be overcorrected with prisms and then brought back to the neutral point. If this is done, one may find that a case which was considered of the divergence excess type actually has as much, or nearly as much, deviation for near as for distance.

Because of this varying ability to overcome the divergent deviation by convergence, the opportunity to remeasure the deviation after one eye has been operated upon is welcome and leads to more satisfactory results.

As a result of an experimental study on nonaccommodative comitant strabismus in adults in 1943, I have used a series of measurements of the amounts of recession and resection to be done for varying degrees of strabismus. In spite of the disappointments and considerable individual variations in results, I have found them so helpful that I continue to use them. I present these figures for your consideration. They are not intended as absolute figures but only as a basis of forming your own guide.

It will be noted that with increasing total amounts of recession and resection, there is an increasingly greater amount of correction per millimeter of surgery. This is particularly true in the deviations of 40 prism diopters and above. This is not the same as saying that the higher the degree of esotropia, the higher is the correction, as held by O'Brien.[3]

INTERMITTENT EXTROPIA (MIXED TYPE)

| DEVIATION (PRISM DIOPTERS) | RECESSION OF LATERAL RECTUS (MILLIMETERS) | RESECTION OF MEDIAL RECTUS (MILLIMETERS) |
|---|---|---|
| 10 | 4 | — |
| 12 | 2.5 | 2.5 |
| 15 | 3 | 3 |
| 18 | 3.5 | 3.5 |
| 20 | 4 | 4 |
| 22 | 4 | 5 |
| 24-26 | 4 | 6 |
| 28-30 | 4 | 6.5 |
| 32-34 | 4 | 7 |
| 36-38 | 4 | 7.5 |
| 40-45 | 4 | 8 |
| over 45 | 4 | 8 on one, remainder on other except with very high deviation, as discussed |

The treatment of intermittent exotropia may be summarized as follows: The optical treatment includes full or overcorrection of myopia, undercorrection of hypermetropia, dark glasses in bright sunlight, and near work stimulation. The orthoptic treatment includes the teaching of awareness of diplopia, correcting suppressions, and improving fusional amplitudes. In mixed cases convergence exercises are added. Surgically, the pure divergence excess type is treated by recession of the lateral recti while the mixed cases are treated with combined recession and resection or by bilateral resection of the medial recti, depending on preference.

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# ORTHOPTIC TREATMENT

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THE three previous speakers have given us an excellent picture of the physiology, diagnosis, and clinical management of intermittent exotropia. I shall now attempt to follow through with the orthoptic treatment.

Since in the development of intermittent divergence excess there is first divergence, then diplopia, then suppression, this sequence must be reversed in treatment. In so doing, suppression must be overcome by creating diplopia. The establishment of diplopia may be done by means to be outlined later. Once diplopia is established, fusion training is begun. Next, fusional amplitudes must be increased so that the eyes may hold parallelism more easily.

In intermittent divergence excess a greater amount of suppression exists than is frequently appreciated. The initial step in treatment is to overcome this suppression. To do this, the dominant eye is occluded twenty-four hours a day. The type of occlusion should be total and constant. The elasto-plast occludors are preferable and are worn without too much difficulty. The occlusion might be worn for several weeks to several months, depending upon the depth of suppression, age and cooperation of the patient, and the understanding of the parent. In addition, antisuppression exercises are given both in the office and at home. Specifically, with a red filter over the dominant eye, we like to have the patient do tracing and coloring, string red and white beads and make bead designs, and read red and black type. These are very simple and inexpensive exercises for the patient inasmuch as the instructions are easily understood and the materials are inexpensive and easy to procure.

After we have overcome suppression, intensive orthoptic treatment may be started at home and in the office for stimulating diplopia. If it is physically and economically possible, it is preferable to have the patient in the office two or three times weekly for thirty-minute periods.

To elicit diplopia, treatment may be carried out in the following sequence.

First: Stimulation by use of a dark red glass. This may be done by using a very dark red glass over the dominant eye in a dark room, while the patient fixes a light at 20 feet. Usually this type of case appreciates a crossed diplopia very readily if there is little or no suppression present.

When this is accomplished, the patient is placed in a normally lighted office or room and again is checked for diplopia. When he is able to appreciate diplopia, we are ready for step 2, which is the teaching of what is called "conscious diplopia." Conscious diplopia is the awareness of two images when the eyes are not parallel, and the teaching of it will take much effort and concentration on the part of both patient and technician.

The patient is placed at a distance of

Read at the annual Joint Meeting of the American Orthoptic Council and the American Association of Orthoptic Technicians, Oct. 16, 1951, Chicago, Ill.

20 feet from a light. He fixes the light with the dominant eye while a graduated red glass is placed before it. The graduated red glass that I use is a ladder on which is mounted a series of red filters, beginning with a very dark, almost black color, gradually shading out into pink, and finally white.

The patient can appreciate diplopia very easily until he gets into the paler shades. Then we have him concentrate on a small light at 20 feet and, with the hand occluder, cover and uncover the deviating eye until he sees a pink light with the dominant eye and a flashing white light with the deviating eye. This is done until he reaches the white-glass stage and can appreciate diplopia with ease and without aid. When he can appreciate diplopia without using the red glass, we then have him look from one image to the other and note the movement of his eyes. To check on this, a prism of the same amount as his deviation is placed base in over the deviating eye. He may see the two lights merge at once, or he may see the two lights approach and fuse as increasing prism base in is used.

A second method, which may be used to establish conscious diplopia, is the use of a vertical prism which may be held base up or base down over the deviating eye. While the patient is observing the vertically displaced images thus produced, the prism is gradually rotated to the base in position until a crossed diplopia is elicited. It will be necessary to use a prism of a smaller degree than the angle of deviation so that fusion cannot occur.

After conscious diplopia has been firmly established, the treatment becomes much easier for the patient, parent, and technician. The teaching of conscious diplopia is also carried out at home. The parent is asked to observe the technic in the office and is instructed to work on this at least twice a day for fifteen-minute to twenty-minute periods with the patient.

The next step in the sequence of treatment is to teach the patient what is often called "control." By this is meant knowing when the eyes are deviated because two images are seen, the ability voluntarily to reduce them to a single image, and then consciously allowing them to appear as two images again. The patient may be unable consciously to bring two images together at 20 feet, so the point less distant is found where the patient can hold "eyes straight." From here, the distance is gradually increased until he is able to do it easily at 20 feet. When the patient finds this difficult, one method which has been found helpful is to place a light at eye level at a point 20 feet from where the patient is sitting, and to interpose a series of objects, such as pictures, blocks, or books in a straight line three or four feet apart on the floor between the patient and the light. The patient looks at these objects from where he sits, beginning with the one nearest to him and observing each in sequence until he gradually raises his eyes to see one light at 20 feet. This may take many attempts, but it becomes easier since the eyes are in a more convergent position when he is looking down than when he looks straight ahead.

Now the patient is taught to appreciate "physiologic diplopia." I want to say here that physiologic diplopia cannot be elicited if there is any element of suppression present, or if the eyes are deviating. In order to elicit physiologic diplopia, it is necessary for the patient to maintain constant fixation on a distant object. While he is fixating at 20 feet, a pencil or a bar is held vertically 13 inches from his eyes, and he is asked how many pencils he sees. If physiologic diplopia is present he will see two pencils. If he sees one, he is told to close his eyes momentarily and again fixate the distant object. It may be necessary

to repeat this many times until at last he becomes conscious of two pencils. Or, while he is fixating the distant object, one can rapidly cover and uncover either eye repeatedly until the patient is conscious of the double near image.

Now he is taught to fuse with a red glass over the dominant eye. Some difficulty may be experienced in maintaining fusion at 20 feet, but again, we find a nearer point where he fuses more easily. Then the distance is gradually increased until fusion is easily maintained at 20 feet.

While the methods already mentioned are being used, fusion can be stimulated on the major amblyoscope. The instrument is set at zero and a gross second grade target is placed in the machine. At this point, the patient should be able to hold his eyes straight, and with the eyes so placed, fusion is stimulated with macular massage. Gradually the size of the targets is decreased. This may be a little difficult at first, but once the patient gets the "feel" of fusion, he works very hard until he masters it. When he has accomplished this, we start to increase his fusional amplitudes. In doing this, we are increasing the divergence power as well as the convergence power, which may seem like a paradoxical situation. However, it is very necessary inasmuch as a divergence excess has little or no active divergence in the beginning.

The methods which may be used to increase amplitudes are varied. These include the use of the major amblyoscope, stereoscope, red glass over one eye with rotary prism, or prism bar, or with loose prisms base in and base out. All of the procedures make it important to the eyes to continue fusing in spite of the fact that an attempt is being made to throw them out of line.

Again, I would like to emphasize that it is not well to try to improve fusional amplitudes until one is sure that suppression has been overcome and good fusion exists under ideal circumstances.

For home use, the amplitudes may be increased by using a stereoscope with base in and base out cards; also, prism bars may be rented.

The home treatment in these cases is most important, just as important as a music pupil practicing his lesson. There should be much reading, tracing, sewing, weaving, bead stringing and model building. The parents are very cooperative when they can appreciate the progress that is being made by working with the youngsters at home.

We must realize that when we treat divergence excess, we frequently have to treat convergence insufficiency as well. Treatment can be carried out by the same methods already discussed, except that the procedures are reversed. Here the aim is to find the nearest point of fusion and bring it closer to the patient. In divergence excess, we find the farthest point at which the patient can fuse and work towards infinity.

In conclusion, there are three points I would like to stress.

1. Suppression existing in this type of case is much deeper than is often realized, and unless it is eradicated, diplopia cannot be elicited, and fusion cannot be achieved.

2. This type of case demands intensive and often prolonged orthoptic training.

3. Finally, the decision for all of the treatment is in the hands of the ophthalmologist, and frequently surgery is necessary, particularly in larger degrees of deviation. However, much better results can be obtained by correlating properly the orthoptic and the surgical treatment.

# INDIVIDUAL CORRECTION OF STRABISMUS

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In trying to reach a conclusion regarding specific treatment and correction for strabismus, I have found that each strabismus patient is an individual and must be treated as such. We do have various classifications of strabismus and certain types of general procedures which may be followed, but there the routine stops. It is simple enough to say we treat accommodatives with glasses and orthoptics; nonaccommodatives with orthoptics and surgery; part accommodative and part nonaccommodative with orthoptics, glasses and surgery; and cases for cosmetic purposes with surgery alone.

However, the various approaches and applications of these corrective measures require individual treatment to bring about the desired correction, so a complex situation develops out of a seemingly simple condition. Strabismus can be treated from two different points of view, either functional or cosmetic. I am certain this group prefers a functional correction for squinters if possible. Otherwise, you would not have gone to all the expense, time and effort to become technicians, and I might add that you would have looked for an easier occupation.

To bring about a functional cure for a squint takes an unlimited amount of patience on the technician's part, a continuous responsibility for the ophthalmologist, an added educational task for the patient and an extra expense for the parents, with complete cooperation by all the persons involved. Unless orthoptics is carried out in a whole-hearted manner, successful results cannot be achieved and neither should they be expected.

It is necessary that training be directed to the individual condition and the problems presented in each case. To break down these conditions and classifications to an individual basis, let us take certain factors and discuss them in detail.

Time probably is one of the largest factors to be considered in squint correction. So much of our work is based on the time element: the time the squint first occurred, the time for orthoptic training to be started, the length of time orthoptics should be given, the time for glasses to be changed and the time for surgery. We work with the time element in planning our treatment for the squints, yet we can actually depend upon these various conditions only as indicators, as individual development governs the methods employed.

With squints, it is necessary to consider time in the abstract only. The amount of time necessary for a correction should be given, and not a given amount of time set for the correction. In my practice, I have ceased to set a time for any definite procedures, but instead I work from indications which arise in the patient's development. This does not imply that an unlimited time is given before definite objective procedures are taken. In fact, an objective lead is necessary throughout the entire

Presented at the Annual Meeting of the American Association of Orthoptic Technicians, Oct. 15, 1951, Chicago, Ill.

treatment of an individual case, but not because the patient has been treated for a certain length of time and something active should be done or because surgical procedures should be taken at a definite age regardless of other factors. The individual indicates the time for various objective measures to be taken at any age and stage in treatment, whether they are mechanical or developmental in nature. These indications can be advantageously used in the very young; so much so, that my treatment of squints begins with infants instead of delaying treatment until the child is 2 years of age, as I did in my early years of squint practice. Treatment has been successfully instituted in infants as early as four months after birth.

It would be a definitely progressive step in treating strabismus if the pediatricians and doctors in general would recognize this fact and refer cases of strabismus at the very first sign of a squint rather than waiting until the child is 2 or 3 years of age. In reaching the infant before a set pattern of seeing has been formed, that is, before the neuromuscular apparatus and sensory system have been completed and stabilized, it is possible in a large percentage of cases to guide development into a binocular pattern instead of waiting and allowing it to become a monocular pattern or an abnormal binocular pattern. Until the child has reached the age of 2 to 3 years, the binocular apparatus, though present except for the accommodative-convergence association, is still far from being stable.

It is this instability which allows us the opportunity to direct a corrective course. Occlusion of the fixating eye serves as a means of treatment. The fixation reflex is present very shortly after birth, and because of this it is possible to begin treatment before the visual acuity has fully developed or can be ascertained. The most common type of squint present from birth is a nonaccommodative one with a paresis of one or more muscles. Fixation may be alternating or monocular. The deviation usually is quite marked and there may appear to be a paralysis of the sixth nerve. Often the head is turned instead of using the lateral rectus. This, however, should not be confused with a paralysis. Interesting factors associated with the paresis are the presence of an overaction of the medial recti and inferior obliques. In addition, frequently an alternating sursumduction is found. Even in an alternating strabismus, usually there is a preference for one eye to fixate. Thus, the choice of the eye to occlude is not difficult in the beginning.

In using occlusion in this manner, it should be kept in mind that merely alternating occlusion and achieving fixation is not the goal desired. It is just the opposite. Every effort is made to keep alternating fixation from becoming a set pattern by not permitting either eye to continue fixating long enough for a definite habit to form, either in an alternating or unilateral strabismus. The rapidity of change in fixation from one eye to the other depends upon the age of the patient when occlusion was begun and the severity of the paresis. The younger the patient and the less severe the paresis, the sooner will the fixation be expected to change.

Adler brings out in his writings that the fixation reflex is an excellent stimulus to the muscle movements of the eyes. This is well demonstrated in infants as it will very soon become apparent after occlusion of the fixating eye; the rotations will improve and soon the head will cease to turn unless the

paresis is very severe. Actually, it is not the visual acuity at this age that is of most concern but the patterns of fixation, rotations and fusional development.

FIGS. 1 and 2—Head tilt and left lateral paresis at 13 and 15 months of age during complete occlusion therapy.

CASE REPORT

Figures 1, 2 and 3 illustrate points of interest in one case treated by complete occlusion therapy. Squint and head tilt had been present since birth. On first examination when the child was 4 months of age, there was a left non-accommodative convergent strabismus of 60 prism diopters with a head tilt and marked paresis of the left lateral rectus. The first two pictures (figs. 1 and 2), taken when the child was 13 and 15 months old, were taken

FIG. 3—Age 4 years, visual acuity normal, head straight at all times, left lateral complete, and parallel alignment of eyes. Complete occlusion only treatment used.

at home, as photographs at this time were not included in the examination at the office. No earlier photographs were available as the parents had purposely not wished pictures of the crossed eyes. When the child was 4 months of age, at the time occlusion was begun, no attempt was made to use the left lateral rectus even when the right eye was covered. The head tilt was twice as marked as shown in the pictures and did not disappear until about 20 months of age. The left lateral rotation

was not complete until the child was nearly 3 years old.

The child is now 4 years old (fig. 3), and the head is straight at all times. Rotations are normal. Versions show an overaction of the inferior obliques. The primary divergence insufficiency present in the beginning has not been apparent during the past year. As a secondary deviation, there is still present an esotropia for near of the convergence excess type. Visual acuity is normal for the age and the refractive error is negligible. Orthoptic training will probably begin during the fifth year.

*Prognosis*: favorable for single binocular vision. Surgery is not indicated as parallel alignment has been achieved through occlusion therapy. A normal relationship of convergence and accommodation should develop successfully through orthoptic training by eradicating suppression for near.

After a fundus examination has been made and occlusion procedures decided upon, the parents are instructed regarding the use of occlusion. They are taught how to make a choice by observation of the fixating eye and to occlude that eye every day. At first, observing the infant for half an hour a day is sufficient to decide which eye to occlude. As development takes place and the preference for fixation changes, a longer period of observation is required before deciding which eye to occlude. When the preferred fixating eye becomes the deviating eye for the first time, the occlusion is left off for a longer period of time, approximately an hour. If during this time the originally fixating eye, which is now the deviating eye, does not resume preference for fixation, the other eye is occluded, but only for two hours. Again the eyes are observed for an hour and if the originally fixating eye has resumed preference for fixation, the occlusion is returned to that eye.

Should the originally deviating eye still be preferred during this observation period, it is possible that at this time the eyes may make movements toward parallel alignment. During this time occlusion is left off and not resumed until the deviation becomes constant. Gradually it becomes possible for the occlusion to be left off for longer periods of time. As periods of parallel alignment increase, occlusion decreases.

About the third year of the child's life, he is ready to attempt the adjustment of accommodation-convergence association which begins to develop around this age. Convergence may still be excessive and the normal association of accommodation-convergence not possible. If this occurs, occlusion is used over the fixating eye for near vision only, if parallel alignment is maintained for distance. Playing with large toys is encouraged and occlusion is left off at times when the deviation is not present. By the sixth or seventh year the accommodation-convergence association should have become fairly well adjusted, but in some cases stability of single binocular vision is not established until the eighth or ninth year. Orthoptic training greatly aids the development of the binocular pattern during the period from the fifth to the eighth year of age by exercises directed toward the convergence excess, increasing fusional range, the development of hand-eye coordination, and single binocular reading.

Ten years ago, squints in children under one year of age were rarely seen in our office, as we were of the opinion that it was soon enough to begin corrective proceedings when the child had reached the age of 2 years. However, it became evident to the late Dr. Grady Clay and myself that we were not meeting the needs of the squinters under 2 years of age. Neither were we taking advantage of the instability present in the very

young that would lend itself to corrective guidance. Instead, we had been waiting for stability to develop so that we would have a set condition to treat. With this in mind, we began treatment of a few infants. The successful response of these cases encouraged us to set the age for squint treatment at the time of the first appearance of the squint rather than waiting until the child was 2 years of age.

It is not always possible to achieve parallel alignment by occlusion in infancy and secure binocular single vision with orthoptic training. However, the increasing successful results that have been obtained justify attempts. Should the desired state not be reached, occlusion still is of value in aiding visual development, improving rotations and preventing abnormal patterns from forming, as well as lessening the deviation.

When deciding upon surgical procedures for the squinter, it is taken for granted that every ophthalmologist desires to achieve the best result possible. He chooses the type of operation he thinks will meet the need of the individual squinter to bring the eyes into parallel alignment. Some of you are better acquainted with squint surgery than others, but all of you see results from surgery and have a record of the type of operation and the amount performed.

Surgical procedures are estimated in millimeters or degrees of arc, but the number of millimeters is not as important in surgery as the fact that the muscle was moved, a point which Dr. Lancaster brought out so clearly. However, surgical information is necessary in relation to orthoptic training postoperatively, particularly if the patient was not seen preoperatively. An incomplete rotation of the muscle involved from surgery will present a mechanical restriction that orthoptic training cannot overcome.

The possible functional cure of any type of squint depends upon the procedures and treatment taken by the ophthalmologist, whether they are surgical, refractive, or other prescribed treatment. No matter how good the technician is and how well the patient responds to orthoptic procedures, if the ophthalmologist does not understand child development and work with these developmental levels, a successful functional result cannot be obtained.

In considering surgery, there are several factors involved. This discussion excludes cases of paralysis and those with pathologic findings. From a surgical aspect, we are concerned with the nonaccommodatives and the part accommodatives-part nonaccommodatives. These cases usually have had a very limited binocular experience or not any. If all our squint cases fell into the group where the deviation did not occur until the ages of three or four years, procedures would be greatly simplified, as usually a binocular background has been present prior to this time.

As a large percentage of the nonaccommodative squints are present from birth, corrective procedures are necessarily more involved. The severity of the complications depends upon the individual case and the age when the patient was first examined. As previously stated, if treatment could be instituted in infancy, the normal reflex development could be used to advantage. However, many squints are not seen for examination before this period is over, and mechanical correction is required. Quite a large number of these nonaccommodative squints are alternators, and fortunately, fixation is good in each eye and the visual acuity has developed normally from birth. Frequently, the deviation is large and the fusional range small. It would seem a simple solution to operate, obtain parallel alignment,

and allow the patient the opportunity to fuse spontaneously. The patient then should develop single binocular vision, have a normal use of the eyes, and be cured.

This does work out satisfactorily in some cases with a past binocular experience. However, in the nonaccommodative group where the squint has been present from birth and no binocular pattern formed, the opposite occurs. After surgery, instead of developing binocular vision, the patient continues his monocular pattern of seeing. The chief reason for this is suppression. This habit was learned when the deviation was too great to allow fusion, and any attempt at bifoveal fixation only resulted in confusion and an undesirable and therefore unaccepted diplopia.

If orthoptics had no other value than serving the purpose of combating suppression, this would be of sufficient benefit to warrant the use of it. Eradicating suppression lies in the orthoptic field and through the efforts of the technicians. The ophthalmologist cannot correct this error by a mechanical means.

The correction of strabismus does depend upon the ophthalmologist's treatment of the case, but in many instances the ophthalmologist must rely on the technician to bring about successful results of his work, from a cosmetic point of view as well as a functional one.

Let it be understood that it is not always poor work on the part of the ophthalmologist but rather the individual's lack of adaptability to the situation. This is another reason orthoptics is desirable and often necessary as it is the only means of teaching the patient how to correct bad visual habits. Through preoperative training the patient learns to accept diplopia, develop binocular vision, and form correct habits of seeing, even though of an artificial nature for a time. In learning to accept diplopia and reject suppression through the guidance of orthoptic training, the patient has overcome one of the greatest problems in squint correction. When the squinter can physically and psychologically accept diplopia, the highest level of orthoptic training has been reached. The remaining corrective measures are almost automatic. With the establishment of binocular vision, either the fusional range allows parallel alignment of the eyes, or they are aligned mechanically.

To achieve single binocular vision is another problem for the individual squinter and the technician. The squinter from birth has not had the experience of the convergence-accommodation association and, unless taught how to make this final adaptation to binocular seeing, becomes confused and falls back to the laws of nature for protection by suppressing for near work. The squinter may find the binocular world quite satisfactory for distance and not mind having a phoria for distance and a tropia for near. However, this should not be necessary, as the progress made in present-day orthoptics offers the squinter an opportunity to learn how to form normal habits of seeing rather than resort to abnormal ones.

The suppression versus diplopia problem is met again in developing single binocular vision for near work, and this may be more difficult than the correction of the original suppression. The patient encounters a psychological problem as well as a visual problem. An undesirable blurred condition must be temporarily accepted willingly and wholehearted cooperation given if single binocular vision is achieved for near work. Suppression is eradicated by ac-

cepting diplopia; diplopia is eliminated by developing sufficient fusional range; blurred images are cleared by learning a normal relationship of accommodation and convergence.

Orthoptics lends itself to individual application in various ways. By one means or another with which you as technicians are familiar, the patient is taught not to suppress but to accept bifoveal fixation. With this accomplishment, surgical procedures are often reduced. We speak of developing fusion before surgery if possible, when actually it is the eradication of suppression that determines functional results.

In the child under three years of age with nonaccommodative squint, even with the best possible surgical results, there is too great an instability present and too great a lack of a bifoveal fixation habit for single binocular vision to develop spontaneously. The eyes may be correctly aligned surgically and fusion may develop for casual seeing, but suppression usually occurs for near. Often an excellent cosmetic result is achieved surgically but suppression is still present, and a monocular pattern of seeing continues. It is my opinion that if children who squint from birth are operated upon before individual indications are present, there remains a residual deviation, suppression continues, and other abnormal patterns of seeing may develop. It should work out that the earlier surgery is performed the better the chance for binocular habits to form through the normal reflex development of the eyes.

However, in the results seen from early surgery, it has been my experience to find in the best results an esophoria for distance and an esotropia for near. More often, there was complete suppression for distance and near.

Other conditions found postoperatively were overcorrection, amblyopia, abnormal retinal correspondence and undercorrection. Surgery on these cases had been done when the child was from one and a half to five years of age. Some of these patients were my own and others were seen by my colleagues in various sections of the country. A few of them had occasional orthoptic observation and occlusion at times, others none at all. Findings on these cases have been taken from six months to eight years postoperatively. In one instance, surgery was continued at intervals over a period of eight years, and the deviation still remained.

The patient, now 15 years of age, whose case is illustrated in figure 4, gave a history of four surgical procedures. The position of the eyes with and without correction is shown in upper two parts of figure 4. The residual deviation from this alternating, part accommodative and part nonaccommodative convergent strabismus was 30 prism diopters for near and 20 prism diopters for distance. After one week of orthoptic training, diplopia was elicited spontaneously (fig. 4, third part). Suppression was eradicated and fusion became spontaneous after three weeks of orthoptic training (fig. 4, last part). Binocular vision was present for casual seeing in four months. Single binocular vision for near without correction developed in a year and a half. Probably orthoptic exercises will be continued for a year longer until this new habit of seeing is fixed. Figure 5 shows the absence of a previous marked overaction of the inferior obliques after binocular development. An abnormal retinal correspondence was not present in this case.

In nonaccommodative squints, if the deviation is too large for preoperative

FIG. 4—Two upper parts show residual deviation after four surgical procedures over a period of 8 years. Third part shows suppression eradicated after one week of orthoptic training at 15 years of age. Last part. Single binocular vision.

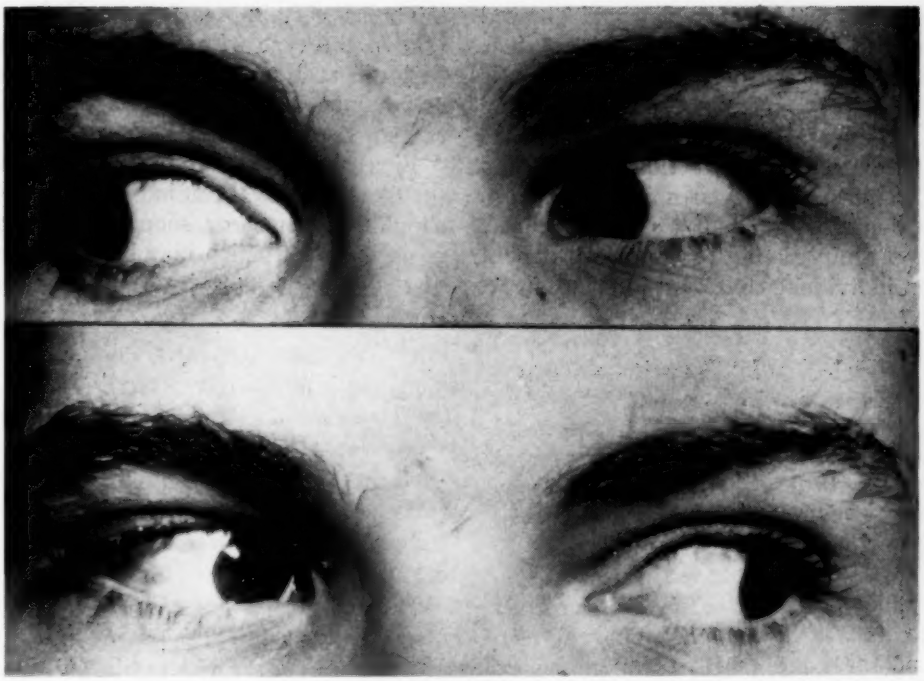

FIG. 5—Absence of previous marked overaction of inferior obliques after binocular development.

orthoptics and the patient too old for infant occlusion therapy, surgery is indicated before diplopia becomes spontaneous. However, before the second operation, it is desirable to use occlusion and preoperative orthoptics.

When the patient can spontaneously accept diplopia but the fusional range is insufficient to overcome diplopia, surgery is indicated. The patient by this time should have reached the age where postoperative orthoptics could be used to an advantage in developing single binocular habits applicable to daily life. Surgery before this time may give a good cosmetic result, but it may also encourage amblyopia, suppression and/or abnormal retinal correspondence if the patient does not accept diplopia and have the ability and stability for overcoming it through fusional development.

Whether the squinter and technician consciously and objectively work toward eliciting diplopia or not, further progressive work cannot be accomplished until diplopia is accepted. That is, the quicker the patient appreciates diplopia, the sooner it can be corrected.

## CONCLUSIONS

When the results of treatment of nonaccommodative squints by occlusion therapy and preoperative orthoptics are analyzed, it is found that the number of successful cases far surpasses that of cases in which surgery and glasses alone were used. Where occlusion therapy did not bring about a correction in itself, it did prevent the formation of a definite

pattern of suppression as well as other abnormal habits of seeing and allowed an individual treatment of the case. Ophthalmologists who use orthoptic procedures can go further in planning an individual correction of strabismus and expecting a functional cure than when surgery or glasses or both have to be depended upon for correction. The opportunity should be given each patient for individual consideration and treatment of various problems involved. Whereas certain developmental levels govern the type of treatment that can be given at a certain age, the age in itself should not be the deciding factor in corrective procedures.

Finally, the most important thing in the treatment of squint is that treatment should be started as soon as the diagnosis is made, which may be at the age of four months.

# STRABISMUS CASES OVER A PERIOD OF YEARS

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THE dismissal of a patient from active orthoptic treatment is a serious step and follows much deliberation and, in some instances, concern on the part of the technician. Each of us, I am sure, feels responsible for his charge not only today, but tomorrow and in the years to come. Our aim is to obtain the best binocular skills of which the patient is capable. Sometimes we succeed, and other times we fail. Just why this is true is still a matter of conjecture and needs more study and research. We must often remind ourselves that we are dealing with human beings, not blocks of wood, and what will do for Johnny will not do for Susie. We cannot develop something that is not there nor give to the patient what he will not strive to obtain. "Orthoptics," says Julia Lancaster, "is not a treatment done to the patient; it is an opportunity offered to the patient. It is subject to the limitations inherent in all opportunities, they may be accepted or rejected by the patient."

Whether Johnny is dismissed, therefore, as a cured patient, or partially cured, or with a purely cosmetic result, the chief thought in the back of our minds is the question of what he will show one year from now, five years from now, twenty years from now. Will his old deviation return? Will he again show anomalous correspondence? Will he lose visual acuity in one eye? Will a surgical overcorrection cause trouble in later years? These and many more questions rise up to confront us as we bid Johnny goodbye and tell him to be a good boy and be sure to do his home exercises.

For this reason I have taken some 40-odd patients at random, called them in and checked symptoms, deviations, and fusional status. These patients have not had active orthoptic treatment for a period of one to ten years. They were not selected but were taken as they responded and include a few who came up to Mary Kramer's standards of a cure, some who were partially cured, some who had had surgery only, and some who did not continue treatment until satisfactory results were obtained. Included are patients with esotropia or exotropia, and a few with postoperative overcorrections. These cases had been under the care of several technicians, which in a certain sense was a handicap. Each technician has her own way of recording her findings, and her own tests which she finds useful, and some of these methods were unfamiliar to me. Consequently I checked only with the cover test, major amblyoscope and Worth four-dot test, and measured visual acuity.

The work done is elementary, mainly for my own interest, and not to prove any points or bring out any startling facts. I realize 40-odd cases are not enough for any statistical analysis, but this is a step toward the goal, and I hope more of us will do some intensive research in this field. I found it fascinating and am sure many of you will, too.

I shall take up the 39 esotropia cases first. My greatest concern is anomalous correspondence, which Dr. Burian defines in these words:

> Anomalous correspondence is said to exist in a patient when elements of the two retinas

Presented at the Annual Meeting of the American Association of Orthoptic Technicians, Oct. 15, 1951, Chicago, Ill.

which are ordinarily disparate—such as the fovea of one eye and an eccentric element of the other eye—prove to have a common visual direction.

Dr. Lancaster says:

Retinal correspondence is not an anatomic peculiarity innate and unchangeable. In squint, anomalous correspondence frequently develops. In this condition a different point of the retina of the squinting eye acquires a more or less perfect correspondence with a point of the non-squinting eye. This is secondary correspondence or anomalous correspondence.

In discussing anomalous correspondence with doctors and fellow technicians it has become apparent to me that there is a difference of opinion in our criteria for it. In order to prevent any misunderstanding I have divided these cases into two groups. Those who show a definite subjective angle less than the objective angle on the major amblyoscope and have crossed diplopia at the objective angle, I have classified as having anomalous correspondence. Those who show a crossing of images rather than a subjective angle but have crossed diplopia at the objective angle, I have listed as cases of retinal non-correspondence or as cases with a tendency toward anomalous correspondence. I shall consider each group separately regarding findings at the beginning of treatment, when dismissed from treatment, and at the 1951 recheck visit, and then shall attempt to correlate them as a whole.

In 10 cases a definite anomalous correspondence was elicited, 80 per cent unharmonious in nature — the angle of anomaly less than the angle of squint. The cover test measurements varied from 10 to 40 prism diopters base out and the acuity was nearly equal in both eyes with the exception of four who had 20/50 or 20/100. All but 3 patients were given intensive orthoptic treatment which varied in duration. Upon dismissal from treatment, 6 had normal correspondence and good fusion with varying ranges of amplitude and degrees of stereopsis on the major amblyoscope. On the whole, the ability to converge was good but divergence was poor. The visual acuity was equal or with but one line difference in all but 1 case, and 80 per cent had one or more operations. None of them, I am afraid, came up to Mary Kramer's standards of a cure. (See page 37.) Six of the 10 did have a phoria with glasses, homonymous diplopia to fusion on the Worth four-dot test, and varying ability on accessory instruments. Without correction, they still had intermittent or constant tropias with one exception. One still had a tropia with good fusion and convergence but an instability for unlike targets on the major amblyoscope.

On the 1951 recheck of the 3 who had surgery only, with no orthoptics, 1 continued to show intermittent exotropia, a good near point, and equal acuity in each eye. The other 2 still had constant exotropia with diplopia and poor acuity in one eye. I had no chance to test them for anomalous correspondence. All 3 complained of headaches.

Of the 7 who had intensive orthoptic training, 2 reverted to constant tropia with the cover test measurement and acuity the same as before orthoptics. One again showed anomalous correspondence; the other, who came closest to the standards for a cure, retained normal correspondence. Upon dismissal these patients had shown slightly lower acuity in one eye and suppression on the Worth four-dot test, which may account for the return to a tropia.

The one patient with tropia varied from an esotropia to an exotropia but still had equal acuity and normal correspondence on the major amblyoscope, with less ability to converge.

The rest still had phorias or intermittent tropias, with good acuity in each eye, fusion with amplitude, and varying

degrees of stereopsis. None complained of discomfort and all were satisfied with their ability to use their eyes.

Of the two patients with postoperative overcorrections, one had esophoria to exophoria with and without correction depending upon the amount of accommodation exerted. A slight increase in deviation was noted in the other from a 7X at distance and 2X′ at near in 1948 to an intermittent 14X(T) at distance and 8X′ at near in September 1951. The mother had noted an occasional turning out of the eye but no other complaints. His convergence on the major amblyoscope and with prism base out remained good, but his stereopsis was only fair.

In this group, the age of onset was 2 to 3 years in 90 per cent of the cases, which would seem to bear out Dr. Burian's statement:

> It is a prerequisite that the patient have a certain amount of binocular cooperation prior to the onset of strabismus, otherwise he cannot develop an anomalous correspondence.

The patients with retinal noncorrespondence showed tendencies toward anomalous correspondence, but the major amblyoscope brought out a crossing of images or alternate suppression rather than a definite subjective angle. All had crossed diplopia at the objective angle and 18 fell into this category. It is of interest to note that the deviations were higher in this group, ranging from 30 to 95 prism diopters base out without correction, with the majority around 50 ET. The acuity was equal or nearly so by the time orthoptic treatment was instituted with one exception. This patient was uncooperative and did not respond too well to orthoptic training. All but one had orthoptic treatment of varying duration and 15 had one or more operations.

After orthoptic training 6 were dismissed for one reason or another still with constant tropias; 2 still had tendencies toward anomalous correspondence and low acuity in one eye. Ten retained either intermittent tropias or phorias, with and without correction, 5 of which fulfilled, or nearly so, Mary Kramer's standards for a cure. These are:

1. Normal or nearly normal visual acuity in each eye with both eyes straight for distance and near without correction.
2. The cover test shows phoria instead of tropia while the patient is accommodating for both distance and near without correction.
3. Fusion for near and far without correction on the Worth four-dot test.
4. Maintenance of the orthophoric position with clear vision on the Remy separator and diploscope without correction.
5. Ability to read and appreciate physiologic diplopia without correction.
6. Ability to keep eyes straight without correction at all times, under all conditions of fatigue, illness or nervous upset.

She goes on to say, "It is obvious that a cure cannot be obtained in all cases of strabismus," which made me feel better about those who did not come up to the standards of a cure.

Fifteen of the cases had normal correspondence with amplitude on the major amblyoscope and stereopsis varying from none to 100 per cent. The acuity was equal and diplopia to fusion was noted on the Worth four-dot test.

On the 1951 recheck, one case which had been converted to a phoria, reverted to a constant tropia. The patient showed 5E and 7E on the cover test, coinciding of angles at 4E, convergence to 36 prism diopters base out and divergence to 2 prism diopters base in. Her acuity was 20/40 and 20/20, and she suppressed the right eye on the Worth four-dot test. The treatments were discontinued by decision of the parents, and the lower acuity and suppression were more than likely contributing factors to the return of the tropia. In 1951 the patient had a constant esotropia of 28 and 36, 20/30

and 20/20, and no fusion on the major amblyoscope. Her original deviation was 52 ET and 56 ET'. The parents were unwilling to continue in 1949 but will do so now.

Of the 6 who had tropias at the time exercises were discontinued, 4 had equal acuity in each eye and 3 had normal correspondence on the major amblyoscope. There was no appreciable change in the amount of deviation, but one had an intermittent exotropia at distance with exophoria at near, another complained of diplopia, and one again had a retinal noncorrespondence.

The deviation remained the same or decreased in all but one patient among those dismissed with intermittent tropia or phoria, acuity equal, and no symptoms.

The one patient who had only surgery and no orthoptics had an intermittent esotropia in 1951 with equal acuity in both eyes and no complaints.

In the normal correspondence group of 11 patients, the deviation ranged from 10 to 60 prism diopters base out, the acuity was about equal in both eyes by the time training was begun, and all had fusion with amplitude on the major amblyoscope with varying degrees of stereopsis. Over 50 per cent showed suppression on the Worth four-dot test. Five had one or more operations.

After intensive treatment, 3 patients still had constant esotropia, fusion with some amplitude on the troposcope, good acuity and fusion to diplopia on the Worth four-dot test. In 1951 they had a greater tendency toward binocular vision than before, becoming phorias to intermittent tropias with about the same or less deviation.

Three cases were partial cures, two coming up to the standards of a cure with correction and one having an intermittent tropia with accommodation. In 1951 two remained the same and the one with phoria had developed a constant alternating esotropia with an increase in his left hypertropia which may have been the reason for the return to a tropia. All other findings were the same.

Five came up to Mary Kramer's standards of a cure and remained the same or improved in 1951.

In reviewing the esotropia cases I would like to repeat that there are not enough cases covered in this paper for any statistical purposes yet certain facts do stand out which might be of interest. Those patients who were dismissed still having anomalous correspondence remained the same in 1951. Of the four surgical patients that had no orthoptics, two still had constant tropias with low acuity in one eye and complaints of headaches and diplopia. Two had developed intermittent tropia with good acuity in each eye and no symptoms.

Of the 10 who still had constant tropias on dismissal, six had normal correspondence in 1951 and four had phorias or intermittent tropias. The acuity was equal in each eye in eight patients. One had reverted to an anomalous correspondence and one complained of diplopia.

Of the 25 who had intermittent tropias or phorias upon dismissal from treatment, four reverted to a constant esotropia, but the remaining 21 still had good single binocular vision or binocular vision at times in 1951.

It is encouraging to note that of these patients, four did have more binocular ability in 1951 than they did when dismissed and that there is little loss of acuity or increase in deviation over a period of years.

I shall consider only briefly the ten patients with exotropia. Three had convergence insufficiency, one had divergence excess, and six had a combination of the two. The deviation varied from an exophoria of 10 D. to an exotropia of 54 D. All responded to orthoptic

training to a certain degree, developing fusion with good convergence ability with and without instrumentation. They had exophoria at near and exophoria to intermittent exotropia at distance. Three had surgical help and two more were advised to have it, but the parents were satisfied as long as the eye deviated only occasionally. In 1951 all but one retained their convergence ability, the deviation remained about the same in all cases, and only one complained of symptoms. She had had 54 XT at distance and near, had two operations, and her convergence ability was slow to improve.

It became apparent to me as I reviewed these case histories that there are many contributing factors to the cause of orthoptic failures and that some patients with phoria again develop tropia often with anomalous correspondence. No one weakness stands out, however, at which we can point our finger and say, "This is the reason." Lower acuity in one eye, suppression on the Worth four-dot test, unstable simultaneous macular perception (in spite of good fusion with amplitude) seem to be warning signals but they do not hold true in every case. It all seems to come back to the individual himself. Johnny is the deciding factor in the end.

In looking over the final results I had a feeling of satisfaction—satisfaction in knowing that while we do not obtain 100 per cent cures and some do revert to a tropia or anomalous correspondence, still the majority benefit by the treatment and hold what they have gained. We cannot perform miracles. We can give to the patient only what he is capable of performing, but we can continue to do our best in the knowledge that on the whole what we are striving for is really worth while.

# THE SUBJECTIVE MEASUREMENT OF THE NEAR POINT OF CONVERGENCE AND ITS SIGNIFICANCE IN THE DIAGNOSIS OF CONVERGENCE INSUFFICIENCY

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CONVERGENCE is a fusional movement brought about by disparate stimulation of the two retinas, but convergence does not come about through disparate stimulation alone. It is the only disjunctive movement that is also under the control of the will.

In the various routine tests for convergence the voluntary and fusional convergence come into play in different degrees. In determining the near point of convergence, we measure largely the patient's ability to converge voluntarily; in determining his fusional amplitudes on a major amblyoscope, we measure his ability to respond to disparate stimulations.

When an object, e.g., a light, is placed in front of a person, he will voluntarily converge his eyes to fixate it binocularly, and as the light is brought closer, he voluntarily increases his convergence with more or less of an effort. The nearest point to which a patient should be able to converge both eyes, the normal near point of convergence, varies according to different authors from 60 to 100 mm.

The measurement thus obtained tells us that the patient can converge so many millimeters, but it may be valid only for the particular condition of the test in which he may have made a special effort. Is the patient also able to maintain in everyday life this ability to converge voluntarily? Is his voluntary convergence active enough to help him in the use of his eyes in prolonged close work?

Read at the annual meeting of the American Association of Orthoptic Technicians, Oct. 15, 1951, Chicago, Ill.

In the ordinary use of his eyes, fusional convergence is of great assistance to him. Ordinarily voluntary convergence and fusional convergence go hand in hand. We are accustomed to find in patients with orthophoria for distance and exophoria for near a remote near point of convergence if the fusional amplitudes are poor, and good near point of convergence if the fusional amplitudes are satisfactory. But this is by no means always found to be so. In such patients, one often finds poor amplitudes and a good near point or, vice versa, good amplitudes and a poor near point. This discrepancy can be explained by the difference in the stimulus situation between the near point test and the test for fusional amplitudes.

How can one take the near point of convergence in such a way as to minimize the role of voluntary convergence, make it correlate better with the fusional amplitudes, and allow one to evaluate the patient's voluntary convergence by comparing the result with the regular near point test? A chance observation suggests the answers to these questions.

A patient, complaining of symptoms not relieved by refractive correction, had a small exophoria for distance and 20$^{\Delta}$ of exophoria for near with poor fusional amplitudes, but a good near point of convergence measured in the routine way. Accidentally, a red filter was also used in measuring the near point of convergence and a considerable discrepancy was found between the regular near point and this red glass near point test. The red glass near point was

quite remote and agreed very well with the amplitudes that were found. Upon treating this patient with red glass near point exercises it was noted that as the red glass near point improved so did his fusional amplitudes. Finally both the regular (objective) and the red glass (subjective) near points coincided, the fusional amplitudes were very good, and the patient was more or less free of symptoms.

Following this experience I have used the red glass (subjective) near point test routinely in a large number of patients and it has helped in many ways, although it has also raised many questions, the answers to which have not as yet been found.

The measuring of the subjective convergence near point is not new; there are instruments, such as Livingston's binocular gauge, which are designed to measure both the objective and subjective near points. Wherever this is done, the subjective near point is determined without colored differentiation of the fields of vision. May I also add that the red glass near point exercises are by no means new to the orthoptic technicians; we assign them for homework in many cases, but the point I wish to make clear is that I do not believe that many of us use them for diagnostic purposes.

The subjective near point of convergence is taken in the same way as the objective near point except that the patient is asked to hold up a red glass in front of one eye. The patient is shown the difference between the white light and the red light and then asked whether there is a "pink light" or "mixed light." The light is held at a distance where it appears "pink" or "mixed," a ruler is held near the lower margin of the orbit of one eye and the fixation light is brought slowly toward the eyes. The patient is asked to tell the examiner just as soon as binocular vision is lost and diplopia results.

This simple test gave us a direct appreciation of the patient's convergence and excluded, in part, voluntary convergence, which was important. I shall attempt to list some of the advantages of the red glass near point test.

Patients with good or fair amplitudes and a good objective near point of convergence sometimes have a poor subjective near point. If the difference between objective and subjective near point is large, this often means trouble for the patient.

For example, a man of 45 came in to have his glasses changed as he was having a great deal of trouble doing close work. This condition had persisted for a number of years. He was given a prescription for new glasses which gave him some relief. On examination we found orthophoria for distance and 15$^{\Delta}$ exophoria with 2$^{\Delta}$ L.H. for near in the prism and cover test with and without glasses. His fusional amplitudes were 4$^{\Delta}$ of divergence and 25$^{\Delta}$ of convergence for distance and 20$^{\Delta}$ of divergence and 40$^{\Delta}$ of convergence for near. His objective near point of convergence was at 65 mm. but his subjective near point was at 140 mm.

In cases in which both the objective and subjective near point are good but the amplitudes are only fair, the prognosis is good. The fusional amplitudes of these patients improved quite rapidly. Thus, T. C., aged 25 years, complained of headaches when she attempted to use her eyes for close work. In the prism and cover test she had orthophoria for distance and 25$^{\Delta}$ exophoria for near. Her fusional amplitudes were 7$^{\Delta}$ of divergence and 25$^{\Delta}$ of convergence. The objective near point was at 50 mm. and the subjective near point at 60 mm. In two or three visits her amplitudes had improved considerably and her symptoms were gone.

In the course of treatment, the recording of both the objective and sub-

jective (red glass) near point each time the patient is seen gives us another important factor. If the subjective near point is remote and the objective near point is good, and if the subjective near point does not improve very rapidly, neither do the amplitudes. An example of this was a 17 year old student nurse who had a severe case of convergence insufficiency. Her prism and cover test for distance revealed orthophoria and 25Δ exophoria for near. Her objective near point was at 220 mm.; with the red glass, her near point of convergence was at 430 mm. Her convergence for distance was 4Δ and for near, 5Δ. The patient was given red glass near point exercises to do at home and when she returned, her objective near point was at 40 mm. and her red glass near point had improved slightly (310 mm.). As might be expected, there was little improvement in her amplitude: 11Δ of convergence with a great deal of effort. After four visits, her objective near point was at 30 mm. and subjective near point was 200 mm. The patient returned three weeks later having worked on nothing but red glass near point exercises, and at that time her objective near point was at 30 mm. and her subjective near point 30 mm. Her fusional amplitudes now showed considerable improvement, amounting to 90Δ of convergence. The patient felt better and she was able to read longer without too much discomfort.

In conclusion, I should like to sum up the reasons why I believe the subjective red glass test for the near point of convergence is of value in the group which we call cases of convergence insufficiency:

1. With the red glass near point test, less voluntary convergence comes into play and there is a better correlation between fusional amplitudes and near point of convergence.

2. This test helps to determine the prognosis of cases where the patient shows good objective and subjective near points but poor amplitudes.

3. The test helps the orthoptic technician to learn what progress is being made since the objective near point improves, in general, more rapidly and the red glass near point test is, on the whole, a more sensitive test.

4. When there is a large discrepancy between objective and subjective near points, this usually indicates trouble for the patient.

# HOME EXERCISES

MARY LOUISE CRONIN
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AFTER a review of the literature which included articles by such authorities as Miss Stark,[5] Miss Healy,[2] Miss Walraven,[6] Miss Roth,[4] and Miss Eyles[1] concerning home treatment for heterophoria and strabismus, I quickly decided that I had nothing new and startling to present. Thus, this is a review of what my associates and I have at our disposal and what we consider and use in orthoptic home training.

Home exercises play a vital part in the treatment of strabismus and heterophoria. As Miss Walraven mentioned in her paper, "The Parents' Role in Orthoptic Training," "...orthoptic training of squint would be greatly simplified if exercises at home could be omitted." We know, though, that if treatment is to be successful, home exercises are usually necessary. Often visits can be made to the office only once or twice a week, and this is but a small part of the time that is needed to stimulate binocular vision. It should be emphasized in talking to the parents that home training saves them time and money but that it should not be taken lightly on this account.

It is imperative to choose the correct time to begin training in cases of strabismus. We must be sure that the correspondence is normal, that there is fusion with some amplitude, and that it is practical to do work at home.

The cooperation of the patient and parent is extremely important. To obtain this cooperation we must be sure that the exercises are clearly understood. Without a clear understanding of what is to be done, it often is just as well or better to omit the exercises, for if they are not done correctly, they will hamper rather than help the condition. It is advisable to demonstrate the exercises thoroughly and it is often wise to write the instructions. An example of the necessity of not only oral but also written instructions occurred in a case in which occlusion was being used for amblyopia ex anopsia. After several weeks the parent was found to be occluding the amblyopic eye.

It is advisable to suggest a time for home exercises that will fit into the child's daily schedule. The time to be spent each day on exercises depends on the age and attention span of the patient. Often it is better to work a short time at different intervals than to persist for one long period. As Dr. Prangen emphasizes, "They are done best when the child is not cross, tired, or hungry." Although we want children to enjoy doing these exercises at home, we must impress upon them that it is work done for the improvement of their eyes. This will aid in the long run when the novelty has worn off and it still is necessary to continue. We must be careful not to prescribe tasks that are too difficult for the patient; interest quickly disappears if the tasks are either too simple or too difficult. The choice of stimuli should depend on what is interesting to the child, whether it be cowboys and Indians or dolls and tea parties.

Frequent checks by the orthoptic technician encourage the patient and aid in evaluating the progress being made. It is helpful to give patients who cannot be seen frequently a report card on

Presented at the Mid-Western regional meeting of the American Association of Orthoptic Technicians, May 6, 1951, Detroit, Mich.

which to note the work they have done. This is often an excellent stimulus for children to do their work. All these things tend to build a close association between the technician and patient or parent and this will further the understanding of orthoptics and its part in the correction of heterophoria and heterotropia. We need to stress the importance of time and patience constantly. Often parents feel that all will be well in a few weeks. Although we do not wish to discourage them, we must avoid confusion in regard to our treatment.

One of the first considerations in treatment of a young patient is to measure visual acuity. I find it helpful for the parent to take an *E* home and play a game with the child. Thus the child becomes familiar with it and, on the next visit, it is usually easy to measure visual acuity with the Illiterate E Chart—both for distant and near vision. The same is true with the picture charts used for very young patients.

When we are occluding because of amblyopia, we must stimulate in the child a desire to see better. Many monocular exercises use bright colors and are interesting. These include coloring, fitting or tracing, puzzles, cutting out dolls, building blocks and sewing picture cards. If the child is permitted to do those activities which he enjoys most, such as blackboard work, reading comic books, or going to movies, he will be happy while stimulating the amblyopic eye for better vision. Dr. L. W. Oaks[3] in his paper on squint amblyopia suggested that active treatment such as embroidery, wood carving, leather work, and clay modeling would furnish a creative aspect to stimulate interest. The View Master with the new light attachment is intriguing with its variety of pictures. Often parents will have some excellent methods of stimulating vision in the amblyopic eye, such as playing games while riding in the car.

The next obstacle to overcome is suppression. In many cases of suppression it is advisable to partially occlude the dominant eye by clear nail polish or scotch tape on the lens. The amount applied will depend on the blurring necessary to reduce the acuity of the better eye below that of the suppressing eye. The red lens or red occluder is especially useful when there is considerable macular suppression. With the use of the red lens over the fixing eye, the red in the material observed is absorbed. This is done when using red and black blocks, red and black typed stories or books, bingo games, and puzzles. For older children sewing and knitting with red thread or red knitting needles are good. A trip through the five and ten cent store will often aid one in finding new games and material to use for these patients.

The cheiroscope also is used for anti-suppression exercise and is good training for eye and hand coordination. In cases of strabismus, prisms must be placed over the lenses when the cheiroscope is used in order to have fusion. Exercises for physiologic diplopia can be done for distant and near vision.

The length of time this treatment for suppression should be continued is highly variable, depending on the cooperation of the patient, the type of suppression present, and the progress being made.

While a patient is being helped to overcome suppression, constant effort should be exerted to make him aware of diplopia. Here, too, the red lens is handy, as are the red and green glasses. When the awareness of diplopia is established, the next step in training is toward development of fusion. The Worth-Black amblyoscope is useful, for it can be adjusted to the angle of deviation where the pictures are super-

imposed. Divergence and convergence can be practiced from that angle in order to build the fusional amplitude. Use of the small amblyoscope at home also will facilitate work in the office.

Recession exercises are among the first things to begin when fusion is obtained. The patient uses a red glass over the nondominant eye and fixes on a light in the distance. If a deviation is manifested, he should see two lights; if his eyes are straight and he is fusing, he should see one light of a pinkish color. When the patient notes diplopia, he should walk toward the light until it is fused and then back away while maintaining fusion. Young children should be supervised to be sure they are not suppressing one eye. This exercise can be continued until true fusion is maintained at all distances. Children enjoy this game because they can devise methods of doing it and they can measure their progress easily.

Some technics which we use for home training are specifically for improving divergence or dissociating accommodation and convergence while others are mainly for stimulating convergence. First I will mention some used in cases of accommodative convergent strabismus. Various types of visual acuity charts may be used for dissociation training. It is important with these that the child be carefully supervised while doing clearing exercises, both at 20 feet (609.60 cm.) and at 13 inches (33.02 cm.). The Remy separator is useful, for accommodation is stimulated while convergence is relaxed. The diploscope also is fine for this dissociation work. Bar reading with physiologic diplopia is also advised. In cases of strabismus, exercises with prisms are best given in postoperative cases in which a small residual deviation exists and fusion has developed before an operation was performed. The strength of the prism would be that which would bring fusion of the two images.

In cases of esophoria, exercises may be tried in which prisms base in are used. First the patient is directed to look at a distant image to help decrease convergence. Gradually the exercise can be done at closer range and finally at near range. For physiologic diplopia, the Remy separator, diploscope, and bar reading with a red glass over the dominant eye are used. The stereoscope with slides that do not permit the patient to converge is interesting to use and aids in developing ability to fuse. The Ortho-Fusor with its three-dimensional pictures is handy for home use. With polaroid glasses the images of the two pictures are fused. Some images are fused with an overconvergence and others with an excessive divergence. When the amount of esophoria is not the same for distant and near vision, we would emphasize working at the distance where help is needed most — depending upon whether there is a divergence insufficiency or a convergence excess.

Now to consider stimulating convergence in cases of divergent strabismus and exophoria. In cases of strabismus when diplopia is recognized, recession exercises with a red lens and work on the cheiroscope are good. The diploscope and Remy separator are used for these cases also. The distance that is emphasized most depends on whether divergence is excessive, convergence is insufficient, or both conditions exist. In many of these cases we use some of the home exercises that are used for exophoria. Prism exercises with base out prisms are used for both distant and near vision. It is in the cases of exophoria with a convergence insufficiency that base out exercises are most successful. The ability to converge is increased by gradually increasing the ability to overcome base out prisms and maintain fusion.

Often the amount of phoria is unchanged, but the convergence amplitude which will give the patient comfort is increased. Convergence on a finger, toy, or piece of candy is always a reliable exercise but often forgotten by patients because of its simplicity. Voluntary convergence can be taught by holding a light a few feet away from the patient while he fixes on his finger at 13 inches (33.02 cm.) from his eyes. This will produce two lights. After practice he should be able to obtain this physiologic diplopia without fixing on his finger. The use of physiologic diplopia also can be incorporated in daily activities by framing objects and bar reading. The stereoscope with base out slides is always good. Other means of stimulating convergence, such as the mirror with a star pasted in the center and stereograms of all types were demonstrated at our exhibit last fall.

Many things that I have mentioned can be used also for patients with concomitant hypertropia or hyperphoria. The object is to increase the restricted vertical fusion amplitude. The home work will consist of recession exercises, stereoscope with base out and base in charts, diploscope, Remy separator, and bar reading. When necessary these exercises can be done at first with a prism correcting the hyperphoria and then this can be gradually reduced until fusion is maintained without it. In this concomitant type of vertical deviation we do not expect to correct the hyperphoria but rather to relieve the patient's symptoms.

In the dissociated vertical divergence type of hyperphoria, time is spent learning voluntary fusion and diplopia — much the same as in an accommodative strabismus. This can be done with a red glass and light—first in a darkened room and later in a lighted room. As in cases of hyperphoria, the cheiroscope, stereoscope and diploscope are used at home. These aids are used to train the horizontal fusional amplitudes without the vertical corection which will aid in overcoming the hyperphoria.

Many more technics for home training could be added. This is only a review of what we have at our disposal for everyday use. We are constantly seeking new types of exercises which will stimulate our patients to make a real effort to bring about maximal visual coordination and visual comfort. Our ultimate aim in orthoptics is to achieve these results.

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# MEASUREMENTS WITH COVER TEST VS. TROPOSCOPE

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NEARLY every orthoptic technician is aware that far measurements of heterotropia made with the troposcope and with the cover test are seldom the same in the same patient. It was the awareness of this difference that prompted the present study. One may ask several questions about such an observed difference: (a) What causes it? (b) Is it consistently present? (c) Is it significant? When the ophthalmologist measures the amount of deviation in a patient with heterotropia using the cover test and the orthoptic technician measures the deviation in the same patient with a troposcope, if the two measurements are not the same the question arises as to which measurement is correct. The answer is that both are correct but that they differ because of differences in the tests themselves.

*Plan of Study*

A sample of 200 patients with heterotropia was used. The lateral deviation of each patient was first measured by an ophthalmologist using the cover test and loose prisms. Measurements were made both at 20 feet (far) in the primary position and at 13 inches (near) with the gaze depressed in the reading position. These measurements were recorded and the patient was then taken to the orthoptic technician in another room. The technician was not shown the results of the cover test measurements but made her own measurements independently on a troposcope. The objective angle was measured at the optical equivalent of infinity and at the equivalent of near by the insertion of -3.00 D sphere into the lens holders on the eyepieces of the instrument. Alternate flashing was used to measure the deviation objectively on the troposcope. We are aware of the fact that the flashing technic frequently elicits a greater deviation than when it is measured with binocular fixation, but we chose the former because this method more nearly duplicates the conditions of the cover test. Troposcope measurements of the objective angle of deviation at far and at near were also recorded. Data for each patient's deviation at far and near by cover test and troposcope were finally recorded in tabular form.

*Method of Analysis*

There are several methods of handling data which are comprised of scores of measurements made on the same patient by each of two tests or measuring devices. The simplest method, that of a direct comparison of scores on two tests, was not applicable here because of the variations encountered in individual patients.

Taking the mean or average of the total scores by each of the two methods would have had some significance, but if score differences were not consistent, this would be hidden by considering only the mean.

Computing the correlation coefficient between scores by each of the two tests seemed to offer possibilities. The coefficient for far scores on the troposcope and on the cover test was found to be

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This study was done under contract with the Office of Naval Research as Project N6onr-202, Task Order I, NR 141-022.

Presented at the Mid-Western regional meeting of the American Association of Orthoptic Technicians, May 6, 1952, St. Louis.

+ 0.80; for near, the coefficient was + 0.79. It is apparent from these two values for r that computing correlation coefficients for near and far scores, while of value, did not throw any light on the problem of the difference under consideration. The fact that r is practically the same for far and near measurements on the troposcope and cover test and that it is high enough to be significant is to be interpreted as meaning only that the two tests rank patients in approximately the same order of amount of heterotropia even though actual scores might be quite different.

We can illustrate the significance of the correlation coefficient applied in this way with an example. Suppose one has five patients—call them A, B, C, D, and E. All have esotropia. When measured with the cover test and loose prisms, A has 1 diopter of esotropia, B has 2, C has 3, D has 4, and E has 5 diopters. When the same patients are measured on the troposcope, A has 5 diopters, B has 10, C has 15, D has 20, and E has 25 diopters. On both tests—cover test and troposcope—A has the least esotropia, E has the most, and B, C, and D are ranked in that order by both tests. In order of the amount of eostropia that is found in each patient, beginning with the smallest deviation, the cover test ranks them in the order of A, B, C, D, E. The troposcope ranks them in the same order. On the troposcope, A had 5 diopters of esotropia, while on the cover test he had only 1 diopter; on the troposcope, E had 25 diopters of esotropia, while on the cover test he had only 5 diopters. Nevertheless, the two tests, although giving different measurements for the amount of esotropia in each patient, *rank patients in the same order* and thus have a perfect correlation, that is, a correlation coefficient of + 1.00.

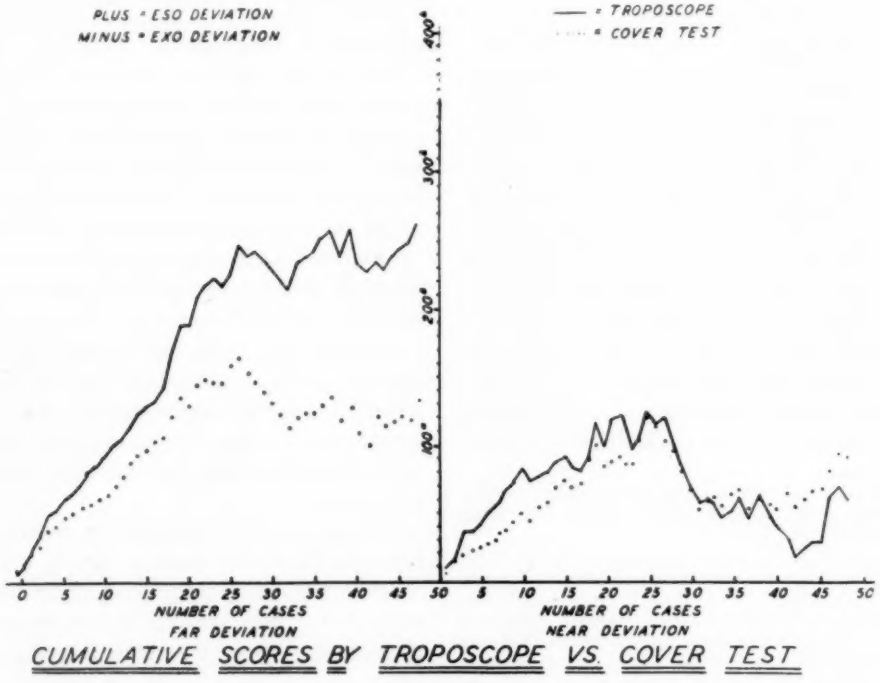


FIGURE 1.

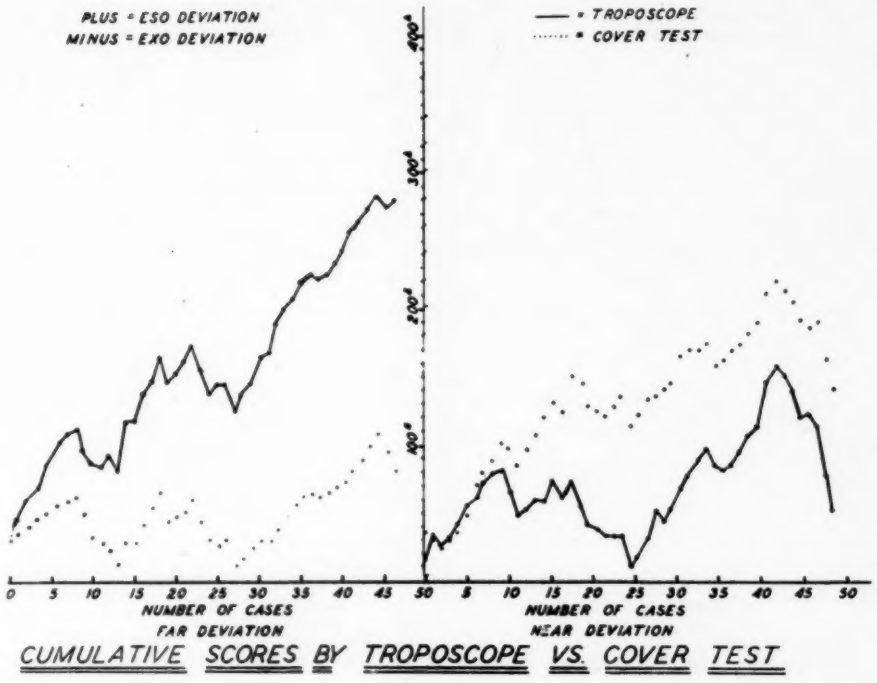


FIGURE 2.

So much for the example. Turning to the actual situation, r for the two tests —troposcope and cover test—was found to be + 0.80 for far and + 0.79 for near. This means that approximately 80 per cent of patients with esotropia will be ranked in the same order by the two tests; the remaining 20 per cent will be out of order. The correlation coefficient tells nothing about actual scores on the two tests.

A variation of the method of cumulative frequency was decided upon as being best suited to answer the question raised in the beginning. If the patient had esotropia, the measurement was recorded as being plus, while exotropia was recorded as minus. On the first graph, at the left, measurements of the deviation at far for the first patient were recorded for each test; measurements for the second patient were added to those for the first and these were next recorded as the second pair of dots (fig. 1). The third pair of dots represent the sum of measurements by each test on the first three patients. The last (the fiftieth) pair of dots represent the cumulative measurements by each test for the first 50 patients. Near measurements were similarly plotted at the right of the graph. The size of the graph limited the sample shown to 50 cases. Three other groups of 50 each are shown in the succeeding charts (figs. 2, 3 and 4). The last graph is a summary plot (fig. 5). Each dot represents a group of 50 patients and the whole sample of 200 patients is represented on this plot. The results are clearly shown and leave no room for doubt. The troposcope consistently elicits greater amounts of esotropia, and less exotropia, at far than does the cover test. At near, however, measurements on the two tests are practically the same and may almost be used interchangeably.

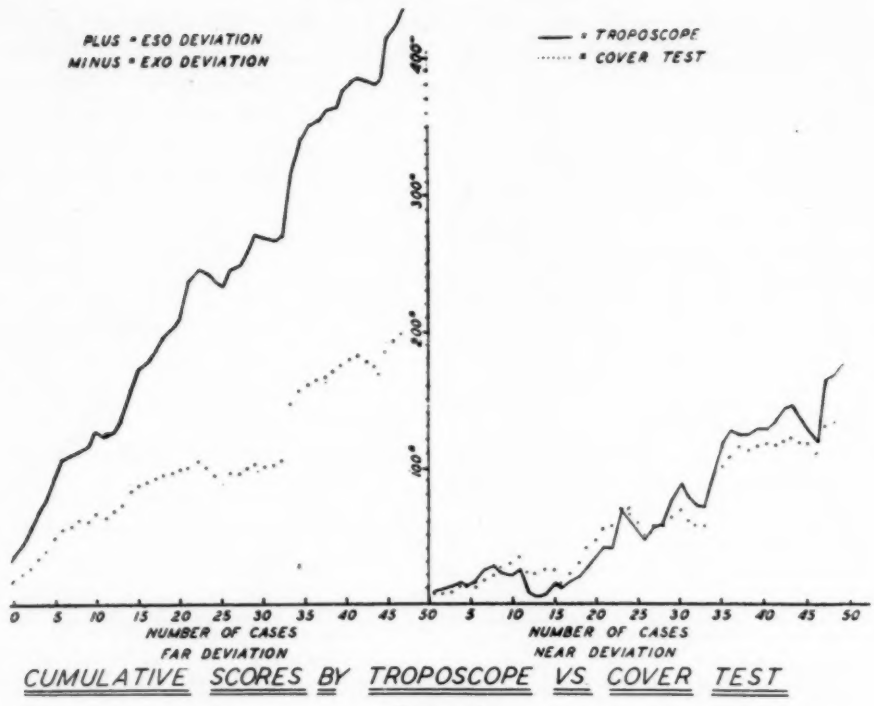


FIGURE 3.

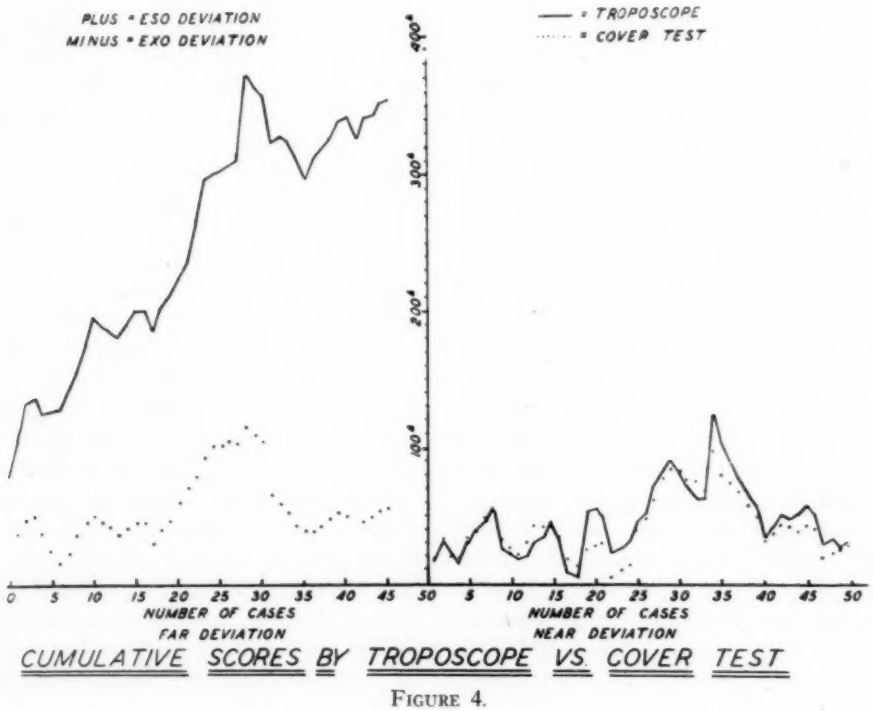


FIGURE 4.

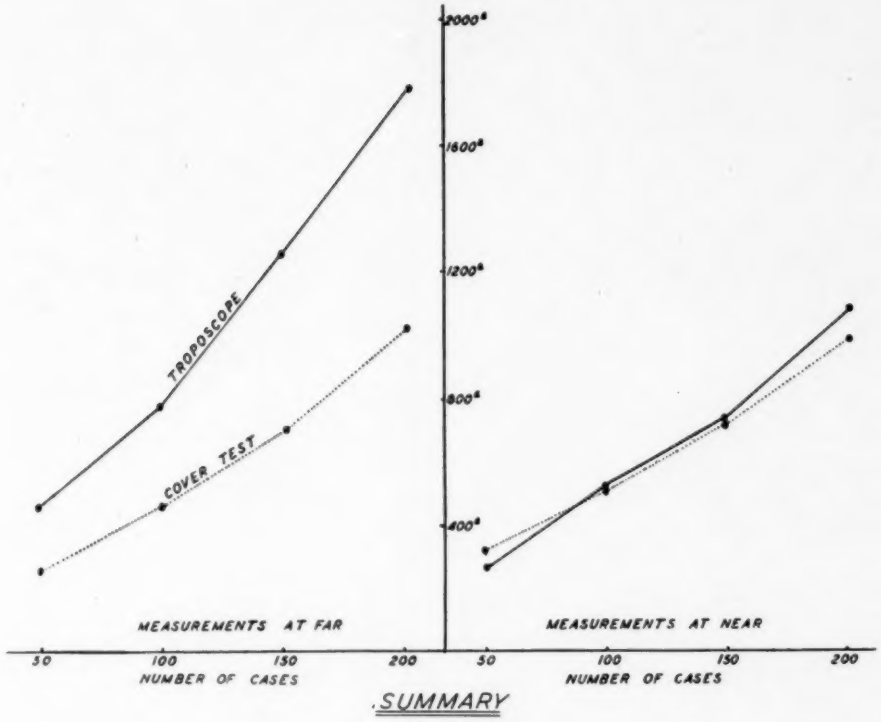


FIGURE 5.

*Discussion*

The clinical observation had been made that at far the troposcope seemed to elicit more esotropia than did the cover test. The danger in clinical observations, unsubstantiated by data, is that one is apt to remember only those cases which happen to fit the theory in vogue at the moment while cases which disagree are forgotten with surprising facility. If a real difference is in fact present and if it is consistent, then proper handling of data will reveal it. The steeper slope of the curve for troposcope measurements of deviation at far, as compared to that for cover test measurements at far, is easily apparent. It is obvious that there is a consistent difference and that it is significant despite the relatively high correlation between the two methods. It would have been nice if the "curves" had turned out to be straight lines because it would then have been possible to calculate regression equations for each line. With such equations it would be possible to take a far measurement of esotropia made on a troposcope and to calculate what the cover test measurement would be for a given patient, and vice versa. It would be possible to convert troposcope measurements to cover test measurements. Since the curves *are* curves and *not* straight lines, this is not possible.

It is interesting that the curves for near measurements on the troposcope and cover test almost coincide. It is obvious that the position of gaze during the cover test at near can not be duplicated on the troposcope. When the cover test is done at near the eyes are depressed in the reading position, while it is impossible to depress the tubes of the troposcope to allow a similar position of the eyes. In spite of this condition there is no obvious difference be-

tween measurements made by the two methods at the near distance. In general therefore, it is possible to substitute near measurements made with the troposcope for those with the cover test and vice versa. The two tests may be expected to give almost identical measurements of esotropia at near in the same patient.

What is the explanation of the difference between the two tests at far? Absolute proof is lacking, but it seems very likely that the difference is the result of what has been variously referred to as instrument accommodation, instrument reflex, machine reflex, machine accommodation, the near reflex, and the awareness of nearness. Far measurements on the troposcope are made at the optical equivalent of infinity. As the patient takes his seat before the machine, he is well aware that the target slides he sees are quite close to him—9 inches away, to be exact. Despite the fact that the optical system is set at the equivalent of infinity, the near reflex stimulates a certain amount of accommodation, which is in turn associated with the convergence response to the awareness of nearness. This probably is manifested in an increased amount of esotropia over that found when the deviation is measured while fixating a muscle light. The fixation object actually is 20 feet away — rather than artificially so. Instrument accommodation is the generally accepted explanation for the apparently greater amounts of esotropia uncovered at far by the troposcope than by the cover test.

At near both troposcope and cover test have the target actually at near so that the awareness of nearness or the near reflex is called into play *by both tests*. Since the chief difference between the two is thus eliminated at near, one would expect the measurements by the two on the same patient to be almost identical and the data have shown that they are.

The data for this study were taken from the files of Dr. Richard G. Scobee —his private patients and patients from the Motility Clinic, Washington University. The cover tests were done by Dr. Scobee. I want to thank Dr. Scobee for his generous cooperation and helpful advice during the preparation of this paper.

## SUMMARY

Measurements of heterotropia at far on the same patient by troposcope and by cover test with loose prisms are not the same. The troposcope consistently reveals more esotropia and less exotropia at far than does the cover test. The difference between the two methods is significant and is probably produced by the factor of instrument accommodation or the awareness of nearness. Near measurements of heterotropia on the same patient by the two methods are practically identical and are thus interchangeable.

The correlation coefficients for near and for far measurements of heterotropia by the two methods are significantly high; for far it is + 0.80, and for near, + 0.79.

# NYSTAGMUS TREATED BY ORTHOPTICS

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THIS is a report of observations made on 4 patients with congenital nystagmus as well as esotropia. The distinguishing characteristics of each case together with the method of treatment employed are described in some detail. There is almost no literature on the treatment of nystagmus and, while only 4 cases are reported here, it is hoped that further work and study will be stimulated in those interested in the subject.

*Case* 1. The first patient was seen in 1942 when she was 12 years old. The diagnosis was one of congenital nystagmus and right esotropia. The esotropia had become quite obvious by the age of 2 and glasses has been worn for the past eight years.

Upon orthoptic analysis, there was a right esotropia of between 40 and 45 prism diopters. The use of a cover in performing the cover test resulted in a marked exaggeration of the nystagmus. The movements were coarse horizontal ones, and it was noted that the speed of the nystagmus was increased when glasses were worn. The patient was hypermetropic but was wearing an undercorrection of the hypermetropia. Ductions and versions both were normal and so was the near point of convergence.

The patient reported simultaneous perception with first grade targets on a major amblyoscope set at zero and diplopia was homonymous. As the arms of the machine were moved inward (base out), the images were reported to be approaching each other and, finally, the bird was seen in the cage at a setting of 44 diopters base out. Fusion had occurred at the estimated angle and it was also noted that *all nystagmus had stopped.* The corneal reflexes in this position were fairly well centered. When either eye was covered, the nystagmus returned, but when the patient was allowed to fuse at the angle of deviation, nystagmus disappeared. No fusional amplitude could be demonstrated, either divergence or convergence, nor could fusion be maintained in either dextroversion or levoversion. Because the nystagmus had been abolished temporarily when fusion occurred at the patient's angle of deviation, it was decided to begin orthoptic training on an experimental basis.

The patient was placed before an amblyoscope, without glasses, and told to make every effort to hold fusion. Second grade targets were used, the arms were locked at the angle of deviation, and then moved from side to side. When 10 degrees of lateroversion had been secured with the nystagmus still controlled, effort was directed toward obtaining some degree of amplitude. Eventually a full excursion was attained from side to side and then all efforts were directed toward obtaining amplitude.

The goal of these two exercises—lateroversion and amplitude—was, of course, to enable the patient to use in casual seeing the ability that had been demonstrated on the major amblyoscope in order that supplementary home work might be assigned.

A 3 mm. white-headed pin was inserted in the end of a pencil and held at the angle where fusion occurred and nystagmus stopped. It was moved from side to side until full excursions were obtained and then recession exercises were begun. From this point, progress was suprisingly rapid. Within a matter of days, the patient could fuse a muscle light 20 feet away. She could also attain all three grades of fusion on a major amblyoscope set at zero and had amplitudes of from 5 prism diopters base in to 60 prism diopters base out. Nystagmus by this time was under control except in extreme lateroversion. Binocular visual acuity was 20/20 both with and without glasses. Although plus cylinders could by this time be worn without appearance of the nystagmus, they were soon discarded.

Nine visits were all that were required and, as a matter of fact, the last three visits were devoted chiefly to stabilization. Observation at intervals of six weeks was continued for the next few months. The patient has been followed regularly for the past nine years. She is now 22 years old, has attended college, taken a secretarial course, and successfully holds a position requiring constant use of her eyes.

*Case 2.* A boy, 3 years old, had horizontal nystagmus present from birth and a right esotropia of approximately 45 prism diopters. His refractive error under atropine amounted to +1.00 +2.00 ax 90 in each eye. Because of the experience in the first case, his ophthalmologist was asked to prescribe only the cylinders, and this was done. Even the cylinders had the effect of exaggerating the nystagmus, but it was believed necessary to correct this amount of astigmatism in order that visual acuity might be at its best.

He was kept under observation at intervals of four months until he reached the age of 5, at which time his cooperation was such that a satisfactory determination of his fusional status could be made. On a major amblyoscope he, too, had simultaneous perception and homonymous diplopia at a zero setting. He fused at 42 prism diopters base out and all nystagmus stopped at this point. A year later, his visual acuity was 20/40 in the right eye and 20/20 in the left eye with glasses. At this time it was noted that occlusion of either eye resulted in a marked increase in the rate of nystagmus. In the interest of securing equal acuity in the two eyes, however, the left eye was occluded and home work prescribed. After a month of occlusion, the acuity in the right eye was 20/20 and the patient's angle of deviation had decreased to about 20 prism diopters. When he finally reached the age of 7, the routine of therapy described for case 1 was begun and satisfactory results obtained after six weeks. Cylinders in the prescription were gradually reduced and finally discarded by the time he was 8 years old. He now attends school, studies music and participates in sports, and his nystagmus is well controlled.

*Case 3.* A girl, seen for the first time at the age of 10, differed from the other patients described in that she had had an operation for esotropia at the age of 4. The esotropia had been reduced little if at all by the surgery and the nystagmus had remained unaffected. Suppression amblyopia was present in the deviating eye. Constant occlusion was instituted and her visual acuity rose from 20/200 to 20/25 in the amblyopic eye in less than three months.

On a major amblyoscope, homonymous diplopia was present at zero and fusion occurred at a setting of 42 prism diopters base out and 3 prism diopters of vertical. The nystagmus disappeared when fusion occurred at the angle of deviation.

The usual exercises were employed until a relative prism divergence of 12 diopters was attained but, despite this, the angle of deviation for casual seeing showed no apparent reduction and no further progress could be made. Because the nystagmus was controlled within the patient's fusional range, it was decided that the prognosis with further surgery should be good, and this was happily proved to be so. One operation reduced the esotropia from 42 to 20 diopters and a second operation a year later abolished the esotropia entirely. Reduced plus cylinders were worn during the intervening year but were discarded entirely a month after the last operation.

*Case 4.* A girl of 7 had nystagmus, esotropia, and a vertical component which resulted in head tilt. After occlusion because of amblyopia, treatment was begun at the fusion angle of 40 prism diopters base out and with the vertical variable. After she had acquired the ability to hold fusion for a complete lateral excursion and with some degree of amplitude, a fine rotary nystagmus was noted for the first time.

It was found that by returning to the original angle of deviation, placing emphasis on decreasing the vertical, and then stabilizing fusion, the best results were secured. When this had been accomplished, work on the amplitudes was resumed. Home work was prescribed, especially on convergence, and later recession exercises were instituted.

At present, the head tilt is no longer noted and fusion is being stabilized for distance. The vertical component is an obvious obstacle, but it is believed that fusion can be stablized in spite of it and no surgery is anticipated. The nystagmus is well controlled within the fusion range. It is of interest that twice during the incubation period of severe illnesses, the nystagmus in this patient returned for a brief time.

## DISCUSSION

Careful study of the 4 cases presented strongly suggests that nystagmus of the type described is an anomaly of the fusion mechanism. A variation of this type of nystagmus may have been encountered in a man of 32 who had no significant deviation, could fuse at zero on a major amblyoscope, but whose nystagmus did not decrease at all under these conditions. The nystagmus was minimal in dextroversion and maximal in levoversion. He could fuse at zero with second grade targets and the usual routine of orthoptic treatment was followed. After five sessions, the nystagmus was believed to have been reduced to about one-fourth of the original amount. His family reports that his nystagmus is now directly proportional to the amount of fatigue present and that, at times, no movement is noted grossly in the eyes-front position.

With regard to the type of nystagmus described in the 4 cases, several generalizations may be made:

1. All patients were hypermetropic and correction of any amount of either hypermetropia or astigmatism, or both, appeared to accelerate the nystagmus. However, after treatment is completed, a refractive correction could be worn, if necessary, without causing a return of the nystagmus.

2. Anomalous correspondence was not found in any patient. This, I believe, may be due to the fact that the constant shifting of retinal images makes the selection of any particular neuronic pathway impossible.

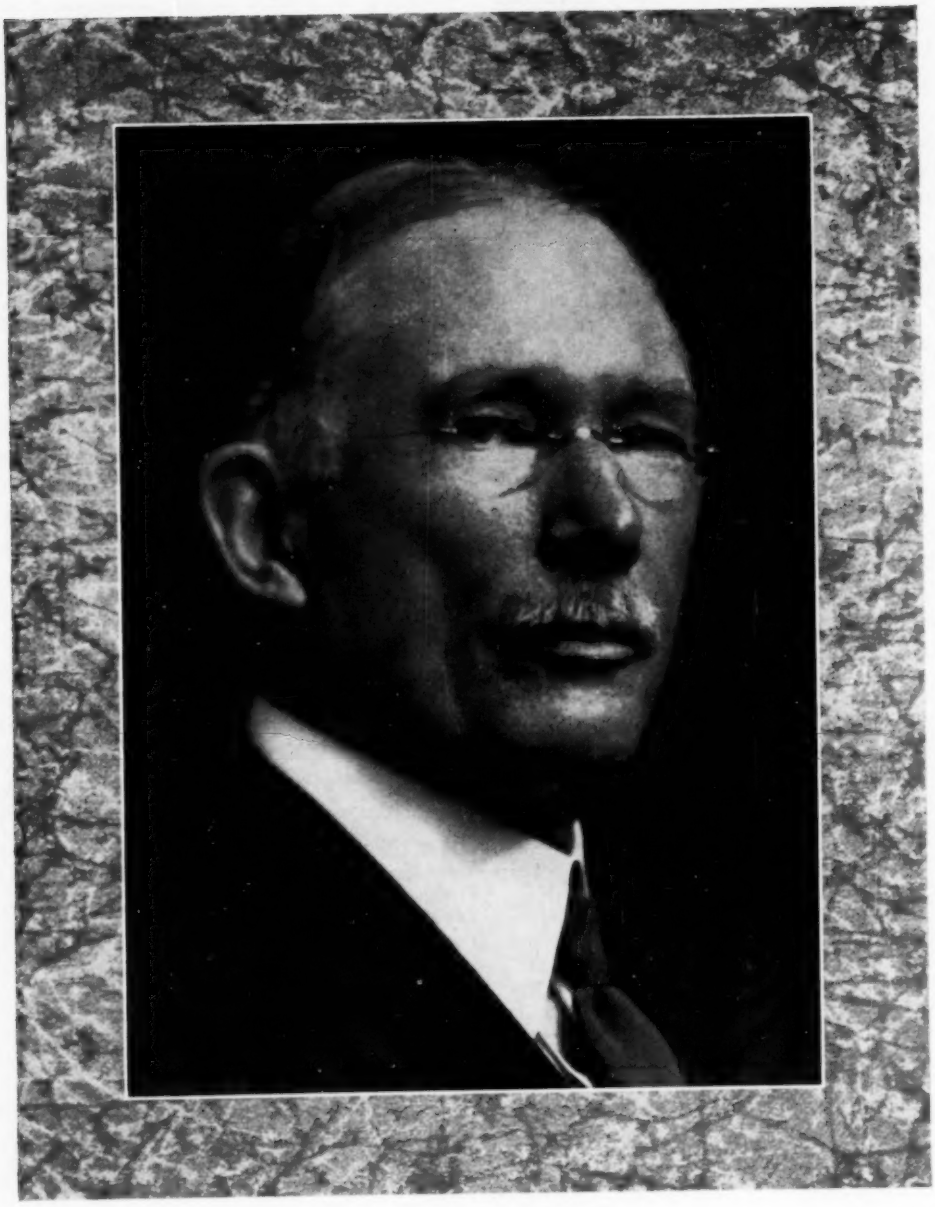
3. Visual acuity in the amblyopic eye seems to return more quickly than in the average case without nystagmus. This is perhaps because the suppression is less well developed in these patients.

4. A varying degree of nystagmus may be found in the extreme lateral positions of gaze even after treatment.

## CONCLUSION

The particular type of nystagmus described appears to be an anomaly of the fusion mechanism and may be controlled entirely, except in extreme lateral positions of gaze. A variation of this type, or a separate type with some of the same elements, may be partially controlled with treatment. Correction of any hypermetropic refractive error results in an exaggeration of the nystagmus. The response to occlusion is good despite the fact that occlusion of one eye often results in exaggeration of the nystagmus. The prognosis for fusion with surgery is good if there is any response to the routine of treatment described and if there is still a residual esotropia.

# In Memoriam



WALTER BRACKETT LANCASTER

1863 - 1951

# AMERICAN ORTHOPTIC JOURNAL

*Published Annually as a Supplement to the Transactions of the American Academy of Ophthalmology and Otolaryngology*



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# Editorials

This memorial issue of the American Orthoptic Journal is an unusual one. In it we have attempted to give proper recognition to Walter B. Lancaster, an ophthalmologist who contributed greatly to ophthalmology for over a half century and was active until his death at the age of eighty-eight. This tribute, and the recounting of his contribution and his honors, was prepared by the Editor of the Journal, Dr. Richard G. Scobee.

With a great sense of loss, we must now announce the death on June 22, 1952, of Dr. Scobee, only a few weeks after he turned in the completed copy for this issue of the American Orthoptic Journal. His death at the age of thirty-eight years cuts short a brilliant career and leaves a host of personal and professional friends to carry on, as best they can, the excellent work he had begun.

Two physicians, one who had lived fully a prolonged professional career, and one who had yet to attain midstream in professional life, have left us. The American Orthoptic Council and the American Association of Orthoptic Technicians shall particularly feel the loss.

JULIA E. LANCASTER,
*President*
American Association of
Orthoptic Technicians

AVERY D. PRANGEN, M.D.,
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FRANK D. COSTENBADER, M.D.,
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American Orthoptic Council

## WALTER BRACKETT LANCASTER
1863-1951

*An Appreciation*

December 8, 1951, marked the passing of a friend.

This issue of the AMERICAN ORTHOPTIC JOURNAL is dedicated to that friend. The goal of this appreciation is not to list his scientific achievements and honors. These are legion and have been adequately listed in the ophthalmologic journals.

Walter Lancaster was unquestionably one of the most outstanding figures in ophthalmology. It is not, however, as the eminent scientist which he was that we prefer to remember him but as a friend. His bushy white brows, twinkling blue eyes, and deep voice which could express scientific fact or whimsical fiction with equal facility will not soon be forgotten. His frequent comment . . . "Oh to be eighty again!" endeared him to many. One writer stated that Walter Lancaster accomplished more between the ages of sixty and eighty-five than most men are able to do in a lifetime.

Candidates taking examinations of the American Board of Ophthalmology were frequently presented with his glasses and the remark, accompanied by a twinkle of the eyes, "What do you think of these?" Part of Walter Lancaster's interest in disturbances of ocular motility undoubtedly came from the fact that he himself had one which was adequately compensated by prisms. To many an apprehensive candidate, Dr. Lancaster's glasses with both horizontal and vertical prisms represented a terrifying enigma. He was delighted on one occasion when a friend, after examining the lenses, offered to prescribe a better pair.

During his early days in medicine, Dr. Lancaster desired to spend some time studying in Europe, and this he did. When he arrived at one well-known English hospital, he found that the class of the Chief of the Eye Service was already filled. There was, however, a young instructor who had no students at all and so Walter Lancaster enrolled with him and studied with him for several months. "That instructor," grinned Walter Lancaster, "was Ernest Maddox!"

It was a rare privilege to sit at the side of Walter Lancaster and listen to anecdotes about famous men in the field of ophthalmology—men who are but names to most of us but whom Dr. Lancaster knew well. His stories made them live again.

One of his greatest achievements in the field of orthoptics was the initiation of what is now known as the American Orthoptic Council's Summer Course. Not only did he start this course but it remained under his direction as long as he lived. He held the firm belief that an orthoptic technician should be firmly grounded in anatomy, physiology, and optics. His concept of the role of the orthoptic technician in medicine was crystal clear. The many technicians who sat in his classes will always be grateful for the knowledge which was his to impart.

Gentle, thoughtful, kind, honorable, sincere, scholarly, humorous, philosophical — Walter Lancaster was all of these and more. He is no longer with us in the flesh and that is our loss. His work, his thoughts, and his spirit remain and that is our gain. His place in American orthoptics was unique. It can never be filled by another.

RICHARD G. SCOBEE, M.D.

## RICHARD G. SCOBEE

1914-1952

Orthoptics lost one of its great champions when Richard G. Scobee died suddenly of coronary occlusion on the evening of June 22, 1952.

Born in Sherman, Texas, on November 14, 1914, he spent much of his early life in El Paso, moving later to Houston, Texas. He completed his premedical work at Rice Institute in Houston, and received the A.B. degree from that school in 1935. He was graduated from the University of Texas Medical School in 1939, after which he served a rotating internship at the Methodist Hospital in

Fort Worth, Texas. In July, 1940 he came to St. Louis for specialized training in ophthalmology at the Washington University School of Medicine and completed his residency training at Barnes Hospital in St. Louis in 1942. He was certificated by the American Board of Ophthalmology in 1943 while working as a full-time instructor in the Department of Ophthalmology of the Washington University Medical School. In January, 1944 he entered the Air Force, then a branch of the Army of the United States, and was assigned to the Department of Ophthalmology of the School of Aviation Medicine at Randolph Field, Texas. In September, 1945 he returned to St. Louis as Director of Graduate Training in Ophthalmology at Washington University School of Medicine, a position which he held at the time of his death. He was promoted to the rank of Assistant Professor in 1948.

Dr. Scobee's interest in ophthalmology began even before his medical school days and it was his constant goal throughout his school years to learn all there was to know about his specialty. During his internship, he became interested in obstetrics, and were it not for the fascination of his first love—ophthalmology—he might have become an obstetrician. We are thankful that this did not occur for we now realize how much he has contributed to ophthalmology, especially toward the solution of the many unsolved and mysterious problems in ocular motility.

Assignment to the School of Aviation Medicine at Randolph Field in early 1944 perhaps furnished the situation which was to stimulate his interest in the problems of ocular motility. There he was confronted with many problems concerning normal and abnormal muscle balance which needed immediate answers. In many instances, there were no good answers available so he set about to find them. That he often accomplished his goal is indicated by the many project reports published by the School of Aviation Medicine summarizing his work. The large number of reports indicates the enthusiasm and energy he always seemed to have. Fascination with ocular motility continued after his return to St. Louis in 1945 when he reorganized the "Muscle Clinic," a branch of the General Eye Clinic in the Washington University Clinics, which he supervised until his death. From the first he was keenly aware of the need for orthoptic help and was able to obtain the services of a qualified orthoptic technician late in 1948. Later he organized a training program for orthoptic technicians in his clinic and at the time of his death, his organization employed two full-time technicians, and had just completed training five student technicians. In addition to these local efforts to further the cause of orthoptics, he was instrumental in organizing the instruction courses for orthoptic technicians now held each fall in conjunction with the Academy meeting and the meeting of the American Association of Orthoptic Technicians. Also, he was in charge of the Summer Instruction Course given by the American Orthoptic Council, and was the first editor and guiding light of the AMERICAN ORTHOPTIC JOURNAL.

Dr. Scobee is survived by his wife, his children, and his parents.

It is a peculiar twist of fate that he had just recently written Dr. Walter Lancaster's obituary, which is carried in this memorial issue with his own.

All who knew him will revere his memory and miss the stimulus of his presence. His was a life that ended too soon.

DAVID W. FREEMAN, M.D.

## THE CHALLENGE OF ORTHOPTICS

Orthoptics represents a veritable challenge to the student and an interesting challenge to the established orthoptic technician. There is a boundless wealth of knowledge to be discovered and absorbed by the orthoptic technician. To obtain progress in the field and meet the never-ending problems, the orthoptist is more or less obligated to keep abreast of the current literature, for it is only by knowing the theories presented that one is able to find the solutions to the pressing problems. Not only must we keep informed but we must also contribute what we can in order that collectively we may gain from the individual.

THE AMERICAN ORTHOPTIC JOURNAL is a new addition to the field. We hope that by contributing new and constructive ideas it will maintain its rightful place in orthoptics. As you know, the papers published in the JOURNAL represent those which the editor hopes will be of value to you. The Abstract Committee has selected the pertinent articles that might be of interest and they have tried to present them as lucidly as possible.

To those who have contributed to the JOURNAL we extend our appreciation for their spirited efforts.

NANCY CAPOBIANCO

## PROFESSIONAL RESPONSIBILITY

The orthoptic technician has only recently come into being as a medical affiliate, and in some circles is not accepted as such even yet. This position of incomplete acceptance imposes certain responsibilities which the technician and the ophthalmic medical practitioner must recognize and face squarely.

Technicians come from many social and educational walks of life and begin their careers at varying ages. Ophthalmologists, on the other hand, have similar premedical educational requirements, conform to somewhat standard professional training, and begin their careers at about the same ages. These differences in training of the technician and the ophthalmologist may at times cause friction. Fortunately, this happens infrequently, since a greater understanding of each other's problems is more often possible.

The orthoptic technician can do much to improve further this understanding by recognizing a threefold responsibility. This responsibility is to the medical public, the medical practice and progress, and to the cooperating or employing ophthalmologist. The patients and the parents are in the hands of the orthoptic technician. They are not able to recognize the difference between good and poor orthoptics. Many times the ophthalmologist can't either. The patient doesn't know whether his time is being used to the best advantage, whether his convenience is being reasonably considered, whether treatment is being well correlated by technician and ophthalmologist, or whether medical honesty, in its best sense, is being served. The technician must be a judge of these things. And on her rests the future of combined ophthalmic and orthoptic practice.

The technician has the further responsibility of frequent consultation with her employing ophthalmologist. She must tactfully refuse to treat patients who cannot profit by treatment. She must encourage further treatment when progress is being made. She must make sure that the termination of her employment does not seriously interrupt important treatment. She must do everything in her power to aid in the training of new technicians.

All of these things are a heavy load for an almost new group of medical affiliates to carry, but to the gratification of the American Orthoptic Council, this burden is being carried increasingly well. Orthoptic technicians are growing in numbers, in knowledge, and in professional responsibility.

FRANK D. COSTENBADER, M.D.

## ZERO VS. ORTHOPHORIA

The meaning of zero is widely known. It requires no definition.

The meaning of orthophoria is, by definition, the absence of any deviation of the eyes from the functional primary position when fusion is disrupted and the two eyes thus dissociated.

Orthophoria means zero deviation under certain specified conditions. Orthophoria and zero are not synonyms and certainly they are not interchangeable, although they are frequently used as if they were.

"The patient relaxed to orthophoria" is often heard and yet a moment's consideration will reveal that it is a ridiculous statement. The mere fact that the patient *had* to relax means that orthophoria was certainly not present — far from it. The speaker usually means that such a patient was able to give up a sufficient amount of convergence to superimpose targets at a zero setting on a major amblyoscope. Those who use the expression seem to derive a peculiar exhilaration from speaking of orthophoria instead of the zero point on a scale. As a matter of fact, orthophoria is a theoretical ideal that is seldom encountered clinically. Whether or not a patient will appear to have orthophoria will depend to a certain extent upon the test used.

In true orthophoria, the foveas of both eyes remain aimed accurately at the object of regard even though one eye is blocked as it is in the cover test. If true orthophoria is indeed present under these circumstances and the cover is then shifted from one eye to the other, there will be no perceptible apparent movement of the object of regard; in other words, the phi phenomenon will not be noted. The patient with fusion who will fail to perceive any apparent movement of a muscle light twenty feet away as a cover is shifted from one eye to the other and back again is indeed rare. When using the cover test, orthophoria seems almost nonexistent.

If the Maddox rod test is employed, patients who see a vertical line running through a light in the absence of any prism held either base in or base out are much more common. With the Maddox rod test, however, the patient who is truly orthophoric for both far and near is very unusual. A certain amount of exophoria at near is considered physiologic by most investigators. One is forced to regard with frank skepticism any statement to the effect that a patient is orthophoric for *both* near and far by any test. Statistically, such a situation occurs less than one out of a thousand times and would be considered such a rarity as to be almost an abnormality.

"This patient varies from 20 prism diopters of esotropia to orthophoria!" Such a report is certainly not rare and it is certainly not true. The patient's deviation may vary from zero to 20 prism diopters, but the very fact that heterotropia is present automatically excludes orthophoria completely.

One also hears oculists and orthoptic technicians alike say, "We got orthophoria in this case." Neither oculist nor technician *got* orthophoria. The patient may have been found to be orthophoric following certain surgical and nonsurgical proceures. The patient attained orthophoria—not the oculist nor the technician. They merely helped.

It is perfectly true that when orthophoria is thus misused for zero, the meaning of the speaker or writer is usually clear to the listener or reader. It is, however, equally true that the speaker or writer is guilty of sloppy and inaccurate usage of words. It is no more effort to say or write a thing correctly than incorrectly and the results are certainly more accurate. A good place to begin is with orthophoria and zero.

†RICHARD G. SCOBEE, M.D.

† Deceased

## ANNUAL MEETING

Twelve instruction courses at the graduate level for orthoptic technicians were made available at the annual meeting in Chicago in 1951 for the first time. Four hundred tickets were sold. During the 1952 meeting, twelve courses will again be presented and they are listed in a subsequent paragraph. These courses are open *only* to (1) members in good standing of the American Association of Orthoptic Technicians and (2) orthoptic technicians who have passed the examination for certification by the American Orthoptic Council but have not yet been formally elected to membership in the A.A.O.T. Tickets may be reserved in advance by those who have paid their dues for 1952. In order for members to assure themselves of tickets for the courses they desire, it is advisable to order tickets in advance. Tickets also may be obtained at the time of registration at the meeting at a desk provided for that purpose. Each technician may take a maximum of six courses, three on Monday morning and three more on Tuesday morning.

1952

COURSES FOR ORTHOPTIC TECHNICIANS

COURSE OT1

Room 702 Period M-3 or T-3

HOME TRAINING TECHNICS IN ORTHOPTICS

Mary W. Argue
Baltimore, Md.

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COURSE OT2

Room 702 Period M-1 or T-1

OPTICS FOR THE ORTHOPTIST

Paul Boeder, Ph.D.
Southbridge, Mass.

---

COURSE OT3

Room 713 Period M-2

THE TREATMENT OF SUPPRESSION AND AMBLYOPIA

Elizabeth Jackson
Erie, Pa.

---

COURSE OT4

Room 793 Period M-1 or T-1

ORTHOPTIC TREATMENT OF HETEROPHORIA IN ADULTS

Electra Healy
Chicago, Ill.

---

COURSE OT5

Room 702 Period M-2 or T-2

NEUROANATOMY FOR THE ORTHOPTIST

John W. Henderson, M.D.
Ann Arbor, Mich.

---

COURSE OT6

Room 743 Period M-2 or T-2

ORTHOPTIC TREATMENT OF VERTICAL DEVIATIONS

Mary E. Kramer
Kansas City, Mo.

COURSE OT7

Room 754 Period M-3 or T-3

DISSOCIATION TRAINING IN ACCOMMODATIVE HETEROTROPIA

Aleatha Tibbs
Washington, D. C.

---

COURSE OT8

Room 743 Period M-1 or T-1

STEPS TO FUSION

Julia E. Lancaster
San Francisco, Calif.

---

COURSE OT9

Room 743 Period M-3 or T-3

THE STEREOSCOPE AND ITS USE

Arthur Linksz, M.D.
New York, N. Y.

COURSE OT10

Room 713 Period M-1 or T-1

VERTICAL ANALYSIS IN HYPERPHORIA

Dorothy Thompson
St. Louis, Mo.

---

COURSE OT11

Room 793 Period M-2 or T-2

THE BLIND-SPOT MECHANISM

Kenneth C. Swan, M.D.
Portland, Ore.

---

COURSE OT12

Room 793 Period M-3 or T-3

TREATMENT OF ANOMALOUS CORRESPONDENCE

Frances Walraven
Atlanta, Ga.

# Abstract Department

Nancy Capobianco, *Editor*

Only articles primarily of interest to the orthoptic technicians are abstracted. A series of 34 classifications for such articles has been designed. There are not abstracts for each class in any one issue of the JOURNAL.

The Abstract Editor would like to thank the following orthoptic technicians for their help in compiling the abstracts:

Leta Counihan
Janet DuBlon
Marilyn M. Evans
Geneva L. Fallon
Helen Fonzi
Dorothy Henderson
Virginia Koehler
Julie Mimms
B. Evelyn Taylor
Ellen Watson

CLASSIFICATION

1. Accommodation
2. Amblyopia
3. Anomalous Retinal Correspondence
4. Convergence
5. Cyclomovements and Deviations
6. Diagnosis
7. Diplopia
8. Divergence
9. Ductions
10. Esophoria
11. Esotropia
12. Etiology
13. Exophoria
14. Exotropia
15. Fusion
16. Heredity
17. Heterophoria
18. Heterotropia
19. Hyperphoria
20. Hypertropia
21. Instruments
22. Miscellaneous
23. Neuro-ophthalmology
24. Orthoptics
25. Paralysis
26. Refraction
27. Suppression
28. Surgery
29. Symptoms
30. Tests
31. Therapy
32. Vergences
33. Versions
34. Vision

## 1-1

Hill, Robert V.: *The accommodative effort syndrome; pathologic physiology,* Am. J. Ophth., 34:423-431 (March) 1951.

Dr. Hill's first report on the accommodative effort syndrome gives us a new viewpoint to think about. He presents a series of reports on diagnosing and effectively treating a common disorder of near-point muscle balance which is designated as the accommodative effort syndrone. The methods are based on a fundamentally different concept of the physiologic relationship of accommodation to convergence than that which has been generally accepted.

Bilateral adduction is the nasalward deviation of the two eyes for the purpose of effecting bifoveal fixation. Bilateral adduction is made up of two components.

1. Accommodative adduction which is an inherited reflex. The purpose of accommodative adduction is one of so aligning the visual axes that they are coordinate with the dioptric distance for any visual task. The stimulus to accommodative adduction is accommodative effort. An excess or insufficient amount of accommodative adduction requires a more gross adjustment of fusional movements in order to maintain bifoveal fixation. A squint may develop in infancy if these movements do not have a chance to develop and adults may complain of symptoms if too much weight is placed on these fusional movements.

2. "True" convergence is a finer, more accurate adjustment of the visual axis. "True" convergence may be positive or negative depending upon whether the fusional adjustment is convergently toward or divergently toward the normal dioptric coordinate for a given state of convergence.

He uses the terms "accommodative enhancement" and "accommodative inhibition" to denote the subconscious desire to keep the image clear.

When the patient is given a near-point visual task, there will be an increased stimulus to adduction, which in turn requires negative convergence to adjust for the normal dioptric coordinate. The negative convergence requires a relaxation of accommodation which is normally overcome by accommodative enhancement which if embarrassed will cause premature blurring when measured with base-in prisms at near.

The accommodative effort syndrome consists of:

1. Asthenopia with near vision, usually coming on within a few minutes after reading, sewing, etc.

2. Increased amplitude of accommodative adduction.

3. Abnormal relaxation of accommodation induced by relative divergence at near (prism base-in blurring at near).

4. Latent convergence insufficiency.

5. A mearsurable abnormality of accommodative function.

## 1-2

Peterson, John H. and Simonson, Ernst: *The effect of glare on accommodation near point,* Am. J. Ophth., 34:1088-1092 (Aug.) 1951.

A study is presented on the effect of glare on lens function in younger and older subjects. Glare was produced by a light bulb within a box 18 inches wide, 18 inches deep, and 20 inches long. The 200-watt light bulb was inserted at the end of the box and the subject faced the opposite end which contained an opalescent glass window. The subject's eyes were 7.5 cm. from the glass window. The glare exposure time was two minutes.

The studies were made on three groups: (1) 42 younger subjects between 20 and 42 years of age, (2) 36 older subjects between 49 and 80 years of age, and (3) 5 aphakic subjects between 60 and 78 years of age.

The younger group of subjects all had perfect visual acuity with and without lenses. The older subjects all had normal or within 10 per cent of normal visual acuity. The variations used were as follows:

1. Accommodation near point was determined before and after glare exposure without artificial pupil. (Artificial pupils were used in some of the experiments to rule out the effect of pupillary size on the measurements and also to cut down the amount of light entering the eye.)

2. Accommodation near point was determined before and after glare exposure with a 3-mm. artificial pupil being used during the exposure and all measurements.

3. Accommodation near point was determined before and after glare exposure with a 3-mm. artificial pupil being in place only during the measurements and removed during the glare exposure.

4. In the aphakic subjects, the near point of vision was determined before and after the glare with no artificial pupil being used at any time.

The effect of glare on accommodation showed the following:

1. In younger people, no effect was found.

2. In older people, a definite lengthening of the accommodation near point was observed.

3. In older aphakic subjects, no definite or significant change in the near point of vision was noted after glare exposure.

4. The change in the accommodation near point in older people is not due to a change in visual acuity.

5. The results agree with the known increased absorption of heat-producing rays by older lenses.

6. The results show that heat effects in the lens produced by the amount of glare used in this work produce a functional reversible change in the accommodation of older people.

## 1-3

Romaine, Hunter H.: *Fatigue of accommodation,* Eye, Ear, Nose & Throat Monthly, 30:140-142 (March) 1951.

The author believes that it is first necessary to ascertain the presence of fatigue of accommodation by a routine examination followed by a careful history which may disclose asthenopic symptoms when reading for an extended period of time; analysis of the discrepancies of the accommodative power for each eye singly or both eyes together; unsatisfactory muscle measurements or poor vergence test; and a thorough physical examination to disclose disease or foci of infection which may be underlying causes. Once the fact that the patient has fatigue of accommodation is established, any underlying causes which may aggravate the condition should be removed.

He describes the stimulation of accommodation and convergence, the use of spherical lenses and clip-on prisms to render the patient temporarily symptom-free and to enable him to study or work during the period of investigation.

## 1-4

Tait, Edwin Forbes: *Accommodative convergence,* Am. J. Ophth., 34:1093-1107 (Aug.) 1951.

This paper presents a detailed analysis of the heterophoric status for distance and near of over 4,500 cases from 10 to 70 years of age who had no ocular symptoms and had single binocular vision. It presents the nature of the accommodation-convergence reflex and the methods of classifications of its values, along with the distribution of the accommodative convergence.

Dr. Tait states that accommodative convergence may be defined as convergence which is induced by the presence of accommodative innervation when, by losing fusional control, the convergence is left free to respond.

After an extensive survey, he summarizes his results by stating that the nature and amount of heterophoria for distance depends on (1) the underlying heterophoria for distance, (2) the amount of accommodation or accommodative innervation present, and (3) the extent to which this accommodative convergence reflex is developed and operative.

## 2-1

David, Friedrich: *Über die gezieltes Training der Macula in der Amblyopiebehandlung,* Ophthalmologica, 121:149-153 (Feb.-March) 1951.

The article presents a method of aiding patients with eccentric fixation. It is designed to project images on the macula of these patients who do not fix with the macula. Diapositives were prepared to fit an ophthalmoscope. The treatment was carried out under cycloplegia. A picture was projected on the macula and the patient was made to name or describe it. When large objects are recognized, smaller ones are introduced. Four cases were successfully treated. The author hopes to publish a fuller paper later.

## 2-2

Hugonnier, R.: *Traitement de l'amblyopie strabique en practique courante,* Ann. d'ocul., 184:1030-1037 (Nov.) 1951.

The author has presented a review of the aims and methods of occlusion. The complete cure of strabismus includes development of binocularity and is not satisfied by parallelism of the visual axes. From all evidence fusion will never be good unless the eyes have equal visual acuity so, of necessity, amblyopia must be cured. In France active methods are not used because of unavailability of the complicated apparatus needed. Passive treatment, occlusion, of the better eye is used. For young children, the author recommends a patch made of a gauze pad covered by adhesive tape, which must cover the entire eye and come over the bridge of the nose. This must be worn day and night, and must not be interrupted by any pretext except to change the patch. For older children who will cooperate, a leather or rubber occluder mounted on the glasses so as to make a single unit, perhaps with an air vent, is recommended. In very young infants the author uses atropinization. One or two drops are used every day, every third day or once a week in the fixing eye. If alternation is produced, the atropine is used alternately in each eye according to which is the fixing eye at the moment.

Partial occlusion is used when the visual acuity has improved but is not yet normal. Types include: (1) bands of paper glued on the glass, 2 mm. wide, separated by a space of 1 mm.; (2) paper or cellophane glued on the glass in one or several layers; (3) Hamblin's Pugh occluders, glass of graded opacities

which reduces the acuity to a predetermined level.

*Management of treatment by occlusion*: Theoretically, total occlusion is continued until the deviating eye is no longer amblyopic. At this time, if the child can cooperate, orthoptic exercises should be given and the occlusion continued until binocularity is good enough to prevent recurrence of amblyopia. If surgery is indicated, it must be done without waiting too long. If, on the contrary, surgery is not done and the child is too young to cooperate, occlusion must be continued (unilateral or alternating). To abandon the occlusion and leave the child without orthoptic training or operative intervention will result in a return of the amblyopia.

*Children aged 5 to 8*: This is the age most frequently encountered by the author, perhaps through neglect of the parents, or more often because they have been content to use glasses, hoping they will correct the strabismus. Glasses should be prescribed, visual acuity measured and then total occlusion started. The child should be seen every 15 days and progress noted. He should be seated near the blackboard and the ordinary work of the class expected of him, making only reasonable allowances for the visual acuity. At home the child should draw, color, etc. Progress is frequently rapid in the first month or 15 days, then it is slowed down. It is unecessary to wait until vision is equal to start orthoptic training, 5/10 or even 4/10 (20/40 or even 20/50) is sufficient, bearing in mind that occlusion must be continued.

When should occlusion be abandoned? In general, if an acuity of 3/10 (20/60) is not obtained in three months, one must discontinue occlusion. Some parents insist that treatment be continued several months, others discourage it from the earliest moment. Practical difficulties dictate one's conduct.

When the visual acuity is subnormal but orthoptics has begun, part-time occlusion can start; it is understood that at the first sign of deterioration of acuity, total occlusion will be resumed.

*Older children*: Improvement is slower but cooperation is better at this age and one is sometimes happily surprised. Occlusion should not be discouraged too easily since it remains the sole chance of re-educating the amblyopic eye.

*Children under 5*: It is important to treat strabismus early. Visual acuity should be determined, if possible, with the Landolt broken rings or with E's. If acuity cannot be determined, the fixating eye should be determined by observation and occluded. The first follow-up should be in 15 days, then more frequently, for at that age there is often a reversal of the strabismic eye. In this case the occlusion is alternated. If improvement is not shown, an organic lesion should be sought. If improvement is shown, occlusion should be continued.

Once alternation is obtained, what should follow? *Occlusion must be continued until the visual axes are parallel,* whatever method is necessary to obtain this. In certain cases, occlusion and glasses will correct the strabismus but this is rare. If the child is old enough, orthoptics should be started. If not, the logical procedure is early operation.

Such early operation has not been accepted in France. However, the author believes this is the only procedure which at this age can bring about parallelism. If occlusion is sufficiently early, on the one hand amblyopia disappears and on the other hand abnormal retinal correspondence is not encouraged. After surgery, binocluar vision can develop; or one can aid it later, if necessary by orthoptics.

## 3-1

Burian, Hermann M.: *Anomalous retinal correspondence; its essence and its significance in diagnosis and treatment,* Am. J. Ophth., 34:237-253 (Feb.) 1951.

Dr. Burian discusses the aspects of normal correspondence and the normal binocular visual act and its adaptability to anomalous correspondence in the case of squint.

He states that while normal correspondence is innate, it is not so rigid that it cannot change should abnormal conditions warrant a change. According to the author, the sensory symptoms evolving from a profound upset in the visual act are only pathological exaggerations of physiologic phenomena. "Anomalous correspondence is an extension, as it were, of the assimilation of the visual directions within Panum's areas which normally takes place in sensory fusion."

Anomalous correspondence consists of rearrangement of the common visual directions of the retinal elements of the two eyes. The acquisition of anomalous retinal correspondence represents an adaptation of the sensory apparatus to the abnormal position of the eyes in an attempt to restore some semblance of binocular vision but which does not include stereopsis and in which retinal elements of markedly different visual acuity are connected.

He discusses the coexistence of suppression and anomalous correspondence and offers a conjecture on the neurophysiology of anomalous correspondence. He also lists (1) the position of the patient's eyes, (2) the consistency of the angle of squint, and (3) the use the patient makes of his eyes as highly important factors in the establishment of anomalous retinal correspondence. The process of establishing abnormal retinal correspondence requires time as well as individual adaptability.

He states that in a considerable number of patients both normal and anomalous correspondence may be elicited, but the ease of eliciting this depends on how deeply the anomalous retinal correspondence is rooted.

He discusses at length the clinical manifestations of anomalous correspondence in which he brings out the point that if the anomalous retinal correspondence is unstable, normal and anomalous localization appear successively in the same or different tests. There are, however, rare cases in which a normal and an anomalous response are elicited at the same time. These patients localize simultaneously in two visual directions with the deviated eye and are said to have monocular diplopia or binocular triplopia. He goes on to explain this in more detail.

The author lays a great deal of emphasis on the diagnosis of anomalous retinal correspondence and the importance of the orthoptic analysis, incorporating a plea to the orthoptists not to use just one test but to use as many tests as possible in determining the presence of anomalous retinal correspondence and its type. His discussion encompasses some of these tests in comprehensive detail as well as various methods of treatment.

He stresses the importance of "proper timing and cooperation between the doctor and the orthoptist" and that daily visits to the orthoptist, even for a relatively short time, are of much greater value than weekly or biweekly visits.

Orthoptic treatment of anomalous correspondence is a luxury and not every patient must be or should be treated. When treatment is undertaken it should be carried out to best advantage in fairness to both the orthoptist and the patient.

## 3-2

Jampolsky, Arthur: *Retinal correspondence in patients with small degree strabismus,* Arch. Ophth., 45:18-26 (Jan.) 1951.

Dr. Jampolsky deals in opposition to the Alder-Jackson, Travers statement that "the incidence of anomalous correspondence increases as the angle of strabismus becomes greater and that anomalous correspondence is seldom found in esotropia of less than 15 prism diopters."

The study has revealed the specific characteristics of the small angle esotropia: (1) the angle of strabismus is less than 15 prism diopters, (2) the strabismus is monocular in type, (3) anomalous retinal correspondence, usually of the unharmonious type, occurs in over 90 per cent of the cases, (4) there is a slight amblyopia of the deviating eye. (5) there is a high incidence of anomalous peripheral apparent "fusion," (6) there is an area of foveal or macular suppression of the deviating eye.

Two case histories are presented to illustrate the important points.

The methods of detecting these small angles of anomalous retinal correspondence depends upon the sensitivity of the test and the method of examination. The more closely the conditions of the method approximate the conditions of casual seeing habits, the more one is able to demonstrate the presence of anomalous correspondence, i.e., the major amblyoscope or the projection apparatus. The more closely the test simulates a laboratory experiment wanting in everyday visual cues, the less one is likely to demonstrate anomalous correspondence, i.e., the after-image test.

On the major amblyoscope, small targets must be used or larger ones so designed that one may detect differences of a few prism diopters.

As regards treatment, the author believes that "attempts to straighten the strabismus by orthoptic methods alone rarely, if ever, meet with success. The presence of an angle of strabismus or angle of anomaly of only a few prism diopters makes it almost impossible to convert the esotropia by orthoptic methods to normal correspondence with fusional amplitude and straight eyes, because the amblyoscope targets used in the usual orthoptic methods must be so small as to make orthoptic treatment impractical."

## 3-3

Schlossman, Abraham: *Diagnosis of abnormal retinal correspondence,* Eye, Ear, Nose & Throat Monthly, 30:25-28 (Jan.) 1951.

The author reviews the concepts of anomalous retinal correspondence and normal ret-

inal correspondence. The tests for determining anomalous retinal correspondence are presented, mainly the maculo-macular test (afterimage test) and the maculo-paramacular test (the amblyoscope and the double-image test). Patients with normal retinal correspondence have an excellent chance of obtaining a good binocular function through orthoptic and surgical procedures. If anomalous retinal correspondence is present, the prognosis is poorer. Patients with facultative anomalous retinal correspondence have a better prognosis than the ones who have a constant anomalous retinal correspondence.

## 3-4

Winkelman, J. E.: *Relative localization in abnormal correspondence,* Ophthalmologica, 119:116 (March) 1950.

In this paper the author describes experiments performed upon patients with periodic alternating divergent strabismus. These patients could achieve fusion in near vision but had an exotropia at the far point. The author states that in these subjects the experiments show that correspondence may be either normal or abnormal. When the patient is fusing, the retinal correspondence is normal. When the eyes are divergent, the correspondence is abnormal. He postulates that these people with intermittent exotropia have two different reflex pathways by which they localize objects. The one pathway is the same as that found in patients with normal correspondence. In discussing the other pathway, the author allies himself with Verhoeff in his views on abnormal correspondence. He believes that there is no combined pathway for localization in abnormal correspondence. Instead, there are two separate pathways for visual impressions, one for the right eye and one for the left. The stimulus received for each eye is localized according to the subjective median plane, and the stimuli from the two eyes are localized with respect to each other via this roundabout path. This indirect localization is much less precise than true retinal localization, and this accounts for the high degree of variability of the distance at which localization is correct.

The apparatus used was ingenious. Two movable boxes were equipped with point sources of light and filters polarized in opposite directions. The subjects wore glasses polarized in opposite directions, so that one eye saw only the light flash from one box and the other eye only the flashes from the other box. The boxes could be placed at varying distances from the eye and varying distances apart. The experiments were performed in a darkened room so that all extraneous clues to localization were eliminated. The phi phenomenon was used.

In the author's experiments the successive flashes of light were either homonymous or heteronymous. Homonymous flashes were described as those in which the light perceived by the left eye was on the left, and that perceived by the right eye was on the right. When successive flashes were homonymous and the first flash to the left and the second to the right, an orthophoric subject would state the light moved from left to right. Likewise, if the flashes were heteronymous (flash for left eye on the right and flash for the right eye at the left) an orthophoric subject would report the light moved from right to left.

Subjects with phorias and normal correspondence were also tested. It was assumed that they were in a dissociated position due to room darkness.

Exophoric subjects with normal correspondence correctly localized the light flashes except when stimulation was *homonymous* at an angle *less* than the subject's angle of deviation. (Diagrams drawn by the author indicate that incorrect localization is due to the fact that the first light flash is on the macula of the straight eye and the second on a templeward retinal area of the deviating eye, resulting in localization is due to the nasal side.)

Esophoric subjects with normal correspondence correctly localized the light flashes except when stimulation was *heteronymous* at an angle less than the subject's angle of deviation. (A diagram indicates this is due to stimulation of a nasal retinal area of the deviating eye and localization to the templeward side.)

Exotropias with abnormal correspondence localized the light flashes like esophoric subjects with normal correspondence. That is, they gave incorrect answers when stimulation was heteronymous at some small angle. The only difference between these exotropic and the normal esophoric subjects is that there was no exact angular distance at which the subjects with abnormal correspondence change from correct to incorrect localization. Instead, there was a varying response during repetition of the test. The author attributes this to existence of two separate, unconnected visual pathways from each eye to the cortex for localization.

## 4-1

Dedimos, P., and Calamandrei, G.: *Sur les troubles de la convergence: étiologie, pathogénie,* Arch. d'ophth., 11: 564-570, 1951.

The authors analyzed 117 cases of convergence insufficiency found among 6,000 private patients. They included patients who had both simple convergence insufficiency and far point exophoria combined with convergence insufficiency. Excluded were patients with refractive errors above one diopter, to eliminate the influence of the refractive error on the convergence anomaly. Also excluded were convergence insufficiencies associated with Basedow's disease, parkinsonism, syndrome of Millard-Gubler, encephalitis lethargica, brain tumors, paralysis of vertical gaze, third nerve paralysis and facial paralysis.

Among the included cases the authors divide the patients into two groups: those in whom the disability appeared slowly and became progressively worse, and those who were suddenly attacked.

In the group of patients who had a rapid onset of convergence insufficiency, two types of etiology were distinguished: convalescence from a serious illness which had been accompanied by fever, and onset during symptoms which suggested an infection of the spinal cord. Among the febrile infectious diseases which preceded a sudden onset were typhoid fever, paratyphus, spinal meningitis, grippe, "cerebral rheumatism," pneumonia, dengue, malaria, pleurisy and even intestinal intoxication.

In the group of patients with a slow onset were found a large number who were nervous, irritable, often depressed, and quite often anemic and weak. These two elements, nervousness and anemia, laid the groundwork for the appearance of convergence insufficiency. Secondary to the nervousness and anemia among many of these patients was a small anomaly of refraction. Often correction of these small anomalies was followed by rapid regeneration of convergence.

Convergence insufficiency was also found among patients with tuberculosis. Among 62 sanatorium patients, 12 were found with insufficiency of convergence. Following amelioration of the tuberculosis the convergence insufficiency lessened.

Toxic conditions were also found. Two patients had quinine poisoning accompanied by lesions of the optic nerve. Patients with toxic states due to overindulgence in tobacco or alcohol frequently improved their convergence with abstinence; insufficiency of convergence in diabetics was made worse or better according to the severity of the hyperglycemia. Other toxic states found were due to chronic nephrosis and lead poisoning.

Many cases with convergence insufficiency have nasal trouble characterized by hypertrophy of the turbinates. The frequency of this association leads the authors to suppose that the nasal affection provokes a relaxation of the neuromuscular tonus which enhances or even provokes the convergence insufficiency. This supposition was confirmed by favorable results obtained by resection of the turbinates.

The authors have observed secondary symptoms which often accompany the classic symptoms of insufficiency of convergence. These are (1) spasm of the central retinal artery, nearly always bilateral, which manifests itself as momentary "blackout" of vision both at near and far, and (2) spasm of accommodation, of short duration, accompanied by pseudomyopia. These symptoms are evidently parallel manifestations of a disturbance of the general nervous system.

The author states that many patients obtain partial relief from prisms of 2 to 4 diopters. No mention is made of the amount of exophoria relieved by these small prisms. They also mention achieving success in several cases by injections of vitamin B.

Prisms were not used to measure the amount of deviation. The authors classify a patient without convergence insufficiency as one who can converge so that the edge of both corneas is within 1 or 2 mm. of the lacrimal ducts and who can repeat the convergence without fatigue. There is no statistical summary of the etiologic causes of these cases but rather a generalized discussion.

## 6-1

Franklin, Dorothy A.: *Differentiation of phi phenomenon and parallax; the use of phi phenomenon in determination of retinal correspondence,* Am. J. Ophth., 34:77-83 (Jan.) 1951.

The author differentiates between the phi phenomenon and parallax as described in the current literature. She indicates that what has been generally termed the parallax test is actually the phi phenomenon. Phi phenomenon, under the name of parallax, is presumed to measure heterotropia. However, since the phi phenomenon, as elicited by the cover test, actually measures phoria and not tropia, this could lead to a possible misinterpretation of

results, as this test might be used to differentiate between phoria and tropia.

"Phi phenomenon is the sensation of movement which occurs when disparate retinal elements are stimulated." However, this movement occurs prior to the movement of the eyes as it takes up fixation when the cover is removed. The use of the test in measuring the phorias depends on the use of prisms to place both right and left images on the foveas until no movement of the light is noted. Therefore the prisms used to stop the apparent movement of the test object measure the degree and kind of phoria present.

She lists three advantages to the phi phenomenon test: (1) it approximates conditions of ordinary vision more exactly, (2) it shows minor degrees of inhibition and (3) it differentiates between a phoria and a tropia when of a small degree, the phi phenomenon being present in phoria and absent in squint.

Motion parallax and binocular parallax are described. Binocular parallax results from the lateral, separation of the two eyes, is proportional to the pupillary distance, and inversely proportional to the distance of the object of regard. Upon this depends the stereoscopic perception of depth.

## 6-2

Hewitt, Robert S.: *Torsional eye movements,* Am. J Ophth., 34:253-260 (Feb.) 1951.

Dr. Hewitt has tried to show the difference between torsion of the globe and oblique movements with the accompanying torsion. The results of a few simple experiments in examining torsional movements with the afterimage, astigmatic dial and the visual acuity method are reported.

## 7-1

Posner, Adolph, and Schlossman, Abraham: *Relation of diplopia to binocular vision in concomitant strabismus,* Arch. Ophth., 45:615-622 (June) 1951.

Postoperative diplopia of various types is discussed and classified by the authors as follows:

1. Diplopia occurring with normal retinal correspondence.
   - A. Cases in which the strabismus was undercorrected. This is often associated with hypertropia.
   - B. Cases in which the strabismus was overcorrected. This is usually the severest and most intractable type of diplopia.
2. Diplopia occurring in cases with abnormal retinal correspondence.
   - A. Mild paradoxial diplopia occurs frequently after operation and is usually self-limited.
   - B. Severe paradoxical diplopia and triplopia; this occurs in the presence of eccentric fixation of the squinting eye.

The authors present two cases, of ten which he has observed, of type 1 B. The first case illustrates postoperative diplopia in a convergent squint and the second is one of divergent squint.

From the ten cases observed it was found that diplopia occurred after surgical intervention. After correction, binocular vision involved areas of the retina which were not capable of suppression; that is, areas were being stimulated that had not previously been exposed to conditions necessitating suppression.

Some of the interesting phenomena such as retinal rivalry, ocular dominance, regional suppression and fusion are described.

With regard to central and peripheral vision the authors believe that peripheral vision is more a primitive function than the recently acquired central vision, more stable, and often remains intact even after suppression of the central area has developed. Peripheral fusion may help the patient to restore binocular single vision either with or without orthoptics or surgery. In these cases there may or may not be a coexistent facultative abnormal retinal correspondence.

## 11-1

Scobee, Richard G.: *Esotropia; incidence, etiology, and results of therapy,* Am. J. Ophth., 34:817-833 (June) 1951.

Dr. Scobee writes on the incidence, etiology and results of therapy in a study of 558 cases of heterotropia, 456 of which were cases with esotropia.

The methods employed by Dr. Scobee in this study are listed in detail. It was possible to give adequate treatment and secure an accurate follow-up on 238 patients. All forms of therapy with the exception of formal orthoptics were given, and 56.7 per cent attained fusion. At the time this study was made, no formal orthoptics was available. Another study will follow in which orthoptics was used.

Almost 28 per cent of 524 patients with heterotropia had the deviation present at birth; 13.5 per cent with esotropia were born prematurely (31 prematures out of 230); 28 per cent with esotropia (90 out of 321) were delivered with obstetrical forceps, and 41 per cent with esotropia had others in the family with the same condition.

Of the 456 patients, 86 (19 per cent) were nonaccommodative; 303 (66 per cent were partly accommodative, and 67 (15 per cent) were purely accommodative.

The average refractive error for the nonaccommodative group was plus 1.18 diopters; for the partly accommodative, plus 3.30 diopters, and for the purely accommodative, plus 4.01 diopters. The incidence of anisometropia was about the same in all three groups.

The result of occlusion for suppresion amblyopia suggest that there is no particular relationship between either the age of onset of esotropia or the duration of esotropia and the level of amblyopia developed in the deviating eye. The data seemed to prove that with occlusion, visual acuity was considerably improved even in an eye crossed from birth; 69 per cent of 91 patients obtained visual acuity of 20/40 or better.

One hundred ninety-five (43 per cent) of 457 patients with esotropia had a vertical component; 49 per cent of the nonaccommodative group; 45 per cent of the partly accommodative and 21 per cent of the purely accommodative had a vertical component. The superior rectus was more frequently paretic than any other vertically acting muscle.

Of 171 patients who had surgery, 46.5 per cent with no vertical component attained fusion, while only 23.6 per cent with a vertical component attained fusion. In the partly accommodative group a vertical component made little difference. In the nonaccommodative group 36.8 per cent without a vertical component attained fusion, but only 18.1 per cent with a vertical component did so.

Significant anatomic anomalies were found with the muscle deviations in 88 cases (51.4 per cent); 90 per cent of nonaccommodatives had anomalies which probably were responsible for the deviation; 43.1 per cent of the partly accommodative cases had anomalies which may have resulted in a predisposition toward the development of an esotropia, a predisposition which became an actual deviation with the addition of the accommodative element.

**15-1**

Colson, Z. William: *Verhoeff's theory of normal binocular vision; an elementary introduction,* Am. J. Ophth., 34:200-204 (Feb.) 1951.

The author presents the principles and experiments explaining Dr. Verhoeff's theory of binocular single vision and stereopsis. He raises the question of whether the usually accepted theory (that fusion of two slightly disparate images forms the basis of stereoscopic vision) is entirely correct. Dr. Verhoeff's original article was published in the *Archives of Ophthalmology,* February 1935.

**15-2**

Winkelman, J. E.: *Peripheral fusion,* Arch. Ophth., 45:425-430 (April) 1951.

Dr. Winkelman describes the method by which he arrived at the concept of peripheral fusion. Although his method was completely different, he confirms Dr. Burian's previous contentions, that identical objects imaged on peripheral disparate points of the retina can induce a fusional movement of the eyes which brings on corresponding points, and that the peripheral fusion may even be so strong as to break the fusion of images situated on the macular region. The stimulation exerted by the peripheral images depends on the size and brightness of these images and on the distance from the fovea. In addition, Dr. Winkleman found that the time of exposure of the peripheral stimulus played a significant role.

**17-1**

Abraham, Samuel V.: *The nature of heterophorias,* Am. J. Ophth., 34: 1007-1016 (July) 1951.

Dr. Abraham discusses the primary position of rest, stressing the relation of phoria to strabismus and to the "position of rest." The data shows that we have no real evidence for assuming that the phoria present will determine the type of strabismus to be expected, if it should occur at any age.

Instead of dividing convergence activity into that part controlled by the fusion faculty and that part controlled by the accommodation, as suggested by Stutterheim, Duke-Elder, and others, the author feels it would be better to divide this function into two closely related types, separated clinically into the voluntary and involuntary form. This fits into the story of the development of convergence, which is discussed at length.

The author, after examining many thousands of cases, found that the cases could be divided into three major groups, which help to explain

the clinical complaints: (1) patients with normal convergence, (2) patients with subnormal convergence, and (3) those with abnormal convergence. These are discussed in full with average figures for each group.

**17-2**

Scobee, Richard G., and Green, Earl L.: *Further studies in the relationship between heterophoria and prism vergence,* Am. J. Ophth., 34:401-404 (March) 1951.

It was found with this further study that the relationship between heterophoria and prism vergences was of clinical value. The convergence-divergence ratio being worked out both for apparent or manifest vergences and true vergences can be of aid in treating patients with the same symptoms and findings. With 12 diopters of divergence, glasses may be of help, while less than 12 diopters will require more than glasses, sometimes surgery. It was found that a patient must have 12 diopters of apparent or manifest divergence at 13 inches if he is to work comfortably at that distance.

**21-1**

Brumback, Joseph E., Jr.: *Fixation-light holder modifications; for screen and cover test in cardinal positions for near,* Am. J. Ophth., 34:897-898 (June) 1951.

Modifications of the commercial fixation-light holder, used for screen and cover test in cardinal positions for near, are presented.

**21-2**

King, J. H., Jr., and Forrest, R. L.: *A modified strabismus muscle forceps,* Arch. Ophth., 46:155-156 (Aug.) 1951.

This article deals with the modification of the Jameson and Prince recession forceps and its aid in lessening the danger of damaging the eye in muscle surgery.

**21-3**

Krimsky, Emanuel: *The stepladder prism,* Am. J. Ophth., 34:1031-1033 (July) 1951.

The stepladder prism differs from the familiar prism rack in that it is of graded strength and is limited to the size of a standard square prism (38 mm. square). Because of its small size, each step or strength of the ladder is made relatively small, but adequate for diagnostic or training requirements. Also because of its small size, the stepladder prism can be used either horizontally or vertically. Another advantage is that it may be inserted in a prism holder which the patient can hold, leaving both hands of the examiner free for holding the flashlight and cover. These can be made in different desired strengths or combinations.

**21-4**

Krimsky, Emanuel: *A combination square prism and lollipop holder,* Arch. Ophth., 46:337-338 (Sept.) 1951.

This new prism holder makes it possible for the patient to hold the prism in the correct manner and leaves the examiner's hands free to hold a flashlight and rotary prism. The holder is inserted in such a way that the prism can be turned base in, base out, base up or down.

**21-5**

McBride, J. P.: *Red-green test in diagnosis of eye muscle anomalies,* Am. J. Ophth., 34:1033-1035 (July) 1951.

The author compares the first red-green test described in 1912 by Dr. W. R. Hess with the Lancaster test (1939), using the same principles but in many ways an improvement over the Hess method. The method for doing the test and an explanation of the interpretation is given in detail.

**21-6**

Putman, Otto A., and Quereau, J. Van Dyke: *The tropophorometer: an instrument employing a new system of coordinates for more accurate measurements of heterophoria and heterotropia,* Arch. Ophth., 45:186-193 (Feb.) 1951.

The authors write further on the tropophorometer, an instrument which has been devised for the purpose of permitting accurate measurements of extraocular muscle anomalies in the six cardinal directions by any of the methods in which a heterotropia or heterophoria is usually measured. Recent improvements include a direct reading feature which speeds up the examination.

**21-7**

Sloane, Albert E.: *Analysis of methods for measuring diplopia fields: introduction of device for such measurements,* Arch. Ophth., 46:277-310 (Sept.) 1951.

It is to the interest of every orthoptic technician to know and understand the diplopia field. Dr Sloane's article is of great use. It is of great importance to have ease in carrying out the test, to be quick and efficient, and to make the patient comprehend the test itself. Therefore the simplest and most efficient method should be used.

There are stated in this article the various methods used for diplopia fields starting from 1876. It is interesting to see how the method has developed. Best known and most widely used is that of Lancaster. Sloane's new device, or the one he has been using and finds very efficient, is very similar to one described by Krusius in 1908. It consists of a small measuring board 18 by 12 inches and is made of a transparent piece of plastic material. Mounted on a light handle it has a small central bulb and a Maddox cross. The examiner holds the screen at 20 inches and holds a red glass in front of the patient's eye. The patient, using the end of a pencil, indicates where the red light is seen. The patient's head can be moved to any position desired and the test repeated.

Maddox' method of measuring the angle of squint, another accurate way of measuring diplopia, is explained in detail.

The prism and cover test also measure the amount of deviation, but in order to use the test accurately White recommends the following requisites: (1) central fixation must be present, (2) there must be sufficient light for eyes to be seen but not too much to annoy the patient, (3) screen or cover must be large enough to cover the eye without distracting the attention of the patient, and (4) the cover must be moved slowly enough for the eye being uncovered to regain fixation.

**22-1**

Allen, James H., ed.: *Strabismus ophthalmic symposium,* St. Louis, C. V. Mosby Co. 1950, as reviewed in Arch. Ophth., 46:110-111 (July) 1951.

This is the first volume of its kind to be published. It is the transactions of the strabismus symposium held at the University of Iowa with Dr. James H. Allen, who has edited the book, as moderator. The country's foremost authorities on this subject have joined their forces and produced a truly useful and interesting book.

**22-2**

Drucker, Arnold P., and Cazort, Ralph J.: *Clinical trial of a new atropinelike drug: the use in ophthalmology of alpha, alpha-diphenyl-gamma-dimethylaminovaleramide (BL 139), a synthetic drug with atropinelike action,* Am. J. Ophth., 34:847 (June) 1951.

BL 139 is a synthetic compound with marked atropine-like action. The effects of this drug were compared with those of atropine and it was found capable of producing mydriasis and cycloplegia both on local application and after oral administration.

The drug was tested clinically on more than 57 normal eyes and 63 eyes showing pathologic conditions.

A 0.5 per cent solution produced cycloplegia comparable with that due to 5.0 per cent atropine solution. A 2.0 per cent BL 139 ointment was found equivalent to 1.0 per cent atropine ointment both for refraction and for therapeutic use.

Preoperative use of a 1.0 per cent solution of BL 139, when combined with the use of a 10.0 per cent neosynephrine, resulted in sustained maximal dilation of the pupil. Pilocarpine and eserine were found ineffective when used following BL 139 administration.

Primary glaucoma was precipitated or aggravated by the use of the drug.

None of the 12 patients sensitive to atropine showed untoward response to the new drug and all have benefited from its use.

**22-3**

Ogle, Kenneth N.: *Optics and visual physiology: Review of literature for 1949 and 1950,* Arch. Ophth., 45:684-703 (June) 1951.

Dr. Ogle reviews the recent literature on such topics as spherical aberration of the eye and its effect in connection with the cause of night blindness, ametropia, aniseikonia, and the value of the contact lens in order to obtain a high magnification of the retinal image in the case of subnormal vision. Visual acuity, ocular functions, binocular coordination, prism (fusion) vergences, stereopsis and several other subjects are covered, making interesting and enlightening reading for both ophthalmologist and orthoptic technician.

22-4

Peckham, R. H., and Harley, R. D.: *The effect of sunglasses in protecting retinal sensitivity,* Am. J. Ophth., 34: 1499-1507 (Nov.) 1951.

Research was conducted, with the cooperation of life guards at Atlantic City, N. J., of the protection afforded from excessive sunlight at the beach by sunglasses of varying densities. Sunglasses of commercial density (35 to 50 per cent) will supply some protection for short periods, say one day or less, but not for a week or more. Darker sunglasses (10 to 12 per cent) will provide protection for periods as long as a week or more. These glasses are commercially available but are in the minority. Failure to wear glasses will result in loss of retinal sensitivity on an average of 50 per cent or, in extreme cases, 90 per cent. Subsequent dark adaptation is delayed for a period of days or weeks after such exposure. This can be of particular danger in night driving and certain types of work. As a pragmatic test, if the wearer's eye can be seen behind the lenses, the lenses are probably not dark enough.

22-5

Walls, Gordon L.: *A theory of ocular dominance,* Arch. Ophth., 45:387-412 (April) 1951.

Brainedness is found to be the primary determinant in the selection of one member of any bilateral pair of structures in the body, with the exception of the eyes. The real basis of an ocular dominance may be sensory, although its obvious manifestations are motor. considering the asymmetrical visual and ocular phenomena which have been advanced as criteria of the sidedness of dominance, Dr. Walls has compiled a noteworthy list divided into five groups.

*Group I phenomena* are asymmetries in which there is no oculomotor element; for example, the dominant eye is the one whose image in a rivalry situation is in consciousness for more of the time than that of the other eye.

*Group II phenomena.* The general character of this group is motor and one recognizes the familar laterality expressed by such terms as "dominant eye" and "master eye" ; for example, the eye with which one aligns a finger or pencil in pointing at another object when both eyes are open.

*Group III phenomena* are not really separable from those of Group II, but are perhaps a little more easily seen to be secondary consequences of a dependence on one eye for the establishment of direction. The eye "nondominant" in this regard has so little responsibility that no harm is done if it deviates from the point of regard, for, according to Dr. Walls' hypothesis, the direction in which that point is seen to lie is wholly determined by the dominant eye. The system as a whole is indifferent to the motor behavior of the nondominant eye just so long as it does not wander so far as to give rise to diplopia. For example, the eye which with bifixation at 20 feet deviates less if covered, or the eye which continues to fixate a target pushed up within the convergence near point.

*Group IV phenomena.* In this group the dominance of the directionalizing eye asserts itself as the "master" eye: it behaves as if it were lazy, as if it were disinclined to leave the primary position and were trying to insist that the "servant" eye do all of the vergences necessary to secure and maintain haplopia. For example, the eye before which one holds a card to read it.

*Group V phenomena* are, in Dr. Walls' opinion, perhaps all meaningless. An example is the eye on the side of the dominant hand.

In connection with the visual perception of space, localization is all-important. Two elements make up the position or locality of a visual point or object: its direction and its distance. It is hypothesized that motor ocular dominance consists in the employment of the patterns of innervation sent to the rotary muscles of one eye only, for the establishment of the perceived egocentric directions of visual objects in either binocular or monocular vision. It is further suggested that in voluntary eye movements, voluntary innervation may normally go to the muscle of the directionally dominant eye only, the other eye being caused to "track" by constellation of well-known reflexes and synkineses.

Some nonclinical and clinical implications of the theory of directional dominance are outlined and discussed, such as the practice of putting prismatic corrections exclusively in the lens before the nondominant eye, and the practice of placing Maddox rods and similar devices only in front of the nondominant eye in diagnostic procedures. The theory does not imply any necessary relation between the extent of heterophoria and the "strength" of dominance.

Several subsidiary problems, raised by the theory, are pointed out, the solutions of which would afford further tests of the validity of the theory.

## 24-1

Burian, Hermann M.: *Scope and limitations of orthoptics in nonsurgical treatment of ocular deviations,* Arch. Ophth., 45:377-381 (April) 1951.

Before giving the scope and limitations of orthoptics in the treatment of squint, Dr. Burian remarks that the general principles governing the treatment of the neuromuscular anomalies of the eyes are surgical, nonsurgical and, in some cases, a combination of both. Surgery has a direct effect only on the mechanical conditions and is the only means by which a permanent change in the relative position of the eyes can be achieved. Innervational conditions are affected only indirectly, so far as these adjust themselves postoperatively to the changed mechanical situation. Nonsurgical means can never achieve a permanent change in the relative position of the eyes but can affect and normalize the innervational conditions. The field of orthoptics comes under the province of the latter method of treatment. In the broadest sense of the word, every form of nonsurgical treatment of neuromuscular anomalies of the eyes is orthoptic therapy and in this broadest sense could be considered to include the prescription of glasses for the normalization of the convergence accommodation relationship.

In considering the scope and limitations of orthoptics then, one may expect orthoptic treatment to do away with certain faults in the monocular and binocular visual act. Orthoptic treatment can never create anything new in the visual act, but can improve or normalize the elements necessary for normal monocular and binocular vision; it can correct pathologic exaggerations or pathologic deficiencies of these elements, such as improving central fixation and the visual acuity of amblyopic eyes; it can combat suppression, and can, in appropriate cases, remove abnormal retinal correspondence. When these visual faults have been done away with, orthoptic treatment may then be expected to encourage proper visual habits and to train those visuomotor functions which are trainable, such as teaching the patient how to dissociate accommodation from convergence. Fusional amplitudes may be increased and improved. When necessary, the near point of convergence may be improved and last, but not least, orthoptic exercises may be expected to give comfortable binocular vision to patients with heterophoria who display symptoms.

It is recognized that orthoptic training cannot change the angle of squint permanently, but it can achieve a change in the angle of squint by transforming a manifest into a latent strabismus. The strabismus, however, will remain only as long as the conditions last which were created by the orthoptic training, otherwise the manifest deviation will return. Orthoptic exercises are powerless where a mechanical or paralytic condition is the underlying cause of the strabismus. Again, it is impossible to compel someone to fuse who is incapable of fusing, just as it is impossible to compel one to perceive depth who cannot see stereoscopically, but the orthoptist can encourage fusion by offering optimal stimulus conditions to make fusion possible. Also, the point is made that some definitely nonorthoptic cases can benefit from orthoptic treatment, when such treatment is judiciously applied. Preoperative orthoptic treatment is much more likely to insure a functional cure following operation than when surgical treatment alone is employed.

It must be remembered that when considering the institution of orthoptic treatment, it is necessary to give individual consideration to every case in all its aspects--ophthalmologic social, medical and educational. Dr. Burian feels that a really clear recognition of the facts relating to the scope and limitations of orthoptics would provide for a happier and more wide-spread co-operation between orthoptic technicians and ophthalmologists.

## 24-2

Burian, Hermann M.: *Strabismus,* Arch. Ophth., 46:73-93 (July) 1951.

This article of Dr. Burian's is a review, attempting to cover the literature on strabismus, for the year of 1950. Under etiology and symptomatology, Dr. Burian shows the different causes or possibilities of strabismus as discussed by other doctors: (1) refractive errors, (2) cortical defects, (3) secondary muscular changes (Piper), (4) supranuclear lesions, (5) psychogenic causes and (6) amblyopia exanopsia.

During the past year anomalous retinal correspondence has received a great deal of attention. Stephenson states that the following factors have little or no influence in the development of anomalous retinal correspondence: (1) amount of the angle of squirt, (2) refractive errors, (3) visual acuity, (4) heredity and (5) the accommodative element.

In this particular section of the report there are many figures given for the patients observed by different doctors and technicians. They show the percentages of patients with harmonious retinal correspondence, unharmonious retinal correspondence and the types of

squints. The binocular phi phenomenon is discussed in relation to the determination of the status of retinal correspondence.

Dr. Costenbader feels that an abnormal convergence innervation is the predominant cause of the misalignment of the visual axes in convergent esotropia. He goes on to suggest a classification of concomitant esotropia.

Part two of Dr. Burian's paper is the nonsurgical treatment, or orthoptic training, for strabismus. Orthoptics treatment is receiving more and more attention in the treatment of strabismus. The first step is to correct refractive errors at the earliest age possible. Occlusion, if necessary, is next, and while the patient is under total occlusion planned exercises should be started. Some advocate immediate surgery after training and immediate training after surgery. Many cases are considered, both those receiving only orthoptic training and those receiving training and surgery.

Part three of Dr. Burian's paper deals with surgical treatment. This entire section states the different opinions in operative procedures. There is a wealth of information to be found by those reading it.

## 24-3

Lyle, T. Keith: *The present position of orthoptics in treatment of manifest and latent strabismus,* Tr. Ophth. Soc. U. Kingdom, 70:19-20, 1950.

Orthoptic treatment is not essentially a method of curing squint but a means of stimulating and re-educating binocular vision. In many cases surgical treatment is indicated. Correct refraction and use of occlusion is of first importance, to be followed by orthoptics in selected cases if the patient is of sufficient mental development to cooperate.

Orthoptic treatment is used to eliminate anomalies of binocular vision such as suppression and abnormal retinal correspondence when they exist, to awaken fusion and develop fusional reserve and stereoscopic vision.

An orthoptic department is concerned with (a) assessment of visual acuity in young children by means of the "E" test; (b) direction and supervision of occlusion to equalize vision of the two eyes; (c) preoperative and postoperative orthoptic exercises in appropriate cases of squint in which restoration of binocular vision is envisaged; (d) cure of certain cases of accommodative concomitant convergent strabismus; (e) cure of certain cases of decompensated heterophoria and (f) cure of most cases of convergence insufficiency.

In the case of children it is urged that they should be brought for advice as soon as the squint is noticed. At present much time is spent in orthoptic departments trying to eradicate abnormalities of binocular vision which have been allowed to develop due to neglect. Early diagnosis and treatment are essential in all cases.

## 25-1

Chamlin, Max, and Davidoff, Leo M.: *Divergence paralysis with increased intracranial pressure; further observations,* Arch. Ophth., 45:145 (Aug.) 1951.

The authors report on further observations of two cases of divergence paralysis with increased intracranial pressure. A summary of a previous paper is presented. Divergence paralysis is described in the following conditions: (1) inflammatory and toxic disease of the cerebrum; (2) cerebral hemorrhage; (3) brain tumor; and (4) head trauma.

From the total of 15 cases observed, the diagnosis of increased intracranial pressure and divergence paralysis was confirmed either at operation or at necropsy. In 8 of the cases a focal lesion was present in the posterior fossa, and in 7 there was not. The only common factor in these cases of divergence paralysis was increased intracranial pressure. Ten of the 15 cases showed definite improvement following relief of intracranial pressure.

The authors are inclined to argue against, rather than for, the existence of a divergence center.

## 25-2

Lyle, T. Keith, and Cross, Alex. G.: *Diagnosis and management of paralysis of the extrinsic ocular muscles, with special reference to surgical treatment in 219 cases.* Brit. J. Ophth., 35:511-548 (Sept.) 1951.

This is a most interesting review of the clinical investigation, etiology, and treatment of 219 of the authors' cases of paralytic strabismus. Many tables and detailed results of operations are given which cannot be abstracted but for which reference should be made to the original article.

Of 219 cases of paralysis of extraocular muscles treated surgically, 47.5 per cent were congenital, 46.5 per cent traumatic, 3.5 per cent due to known organic disease, and 2.5 per cent due to disease of indeterminate origin. Of the 46.5 per cent cases of traumatic origin 28.5

per cent were cerebral injuries and 18.0 per cent orbital.

The muscles most frequently involved were the superior oblique in 39.5 per cent of cases, and the superior rectus in 31.0 per cent. Next in order of frequency were the lateral rectus, 12.0 per cent; inferior oblique, 6.0 per cent; inferior rectus, 4.5 per cent; medial rectus, 2.5 per cent; muscles of Nerve III, 1.5 per cent; muscles of Nerves III and IV, 0.5 per cent; and mixed (2 muscles), 2.5 per cent.

The authors mention the following sequelae of the original palsy which were found upon examination: (1) overaction of the contralateral synergist, (2) contracture of the direct antagonist, and (3) secondary palsy of the contralateral antagonist.

The clinical examination included a detailed history. Diplopia, either in all directions or only in certain directions, was the most common symptom. Tests of muscle activity and fusion included: (1) the cover test, (2) the Maddox rod test at 6 meters, using the rod in front of each eye to determine the primary and secondary deviations, (3) the Hess screen or Lancaster red-green test, and (4) the major amblyoscope. The Hess screen demonstrates the muscle or muscles involved, and the amblyoscope gives the status of binocularity, the presence of suppression, and fusion vergence power.

In addition to the ocular tests, other clinical tests were employed, including urinalysis, Wassermann blood test, roentgenograms of the skull and orbit, lumbar puncture, encephalography, ventriculograms and arteriography, as indicated.

Preoperative treatment included the stimulation of binocular vision by orthoptic methods. If the visual axes are made approximately parallel, a more rapid resumption of normal binocularity will occur if binocular functions have been exercised than if some degree of suppression has occurred.

Sometimes temporary prisms were used to aid fusion until operation was performed. Surgery was done when it appeared that no future improvement in the paralysis could be expected, and when it appeared that any etiologic disease was no longer active.

Operative principles were discussed. Only a brief digest will be given of the very detailed tables which show preoperative and postoperative measurements, history, millimeters of recession and resection, etc.

*Superior oblique paralysis.* In congenital cases, updrift of the paralyzed eye is usually marked and inferior oblique myectomy in most cases gives excellent results. In other cases, if vertical deviation in the primary position is large, it is usually wiser to start by recessing the contralateral inferior rectus and later, by performing myectomy of the ipsilateral inferior oblique, if necesary.

*Superior rectus paralysis.* Partial myectomy of the contralateral inferior oblique is most frequently done. It is best to aim in surgery for orthophoria in depression. If orthophoria in the primary position is attained, there may be distressing diplopia looking down.

*Lateral rectus paralysis.* Recess the contralateral synergist or the direct antagonist, resect the affected muscle or the contralateral antagonist, or do a combination of these procedures.

*Inferior oblique paralysis.* The opposite superior rectus should be recessed or have a marginal myotomy.

*Inferior rectus.* Miscellaneous procedures were used.

*Medial rectus.* Tenotomy or recession of the lateral rectus of the opposite or same eye was done.

Improvement was shown in almost all of the cases operated upon, with orthophoria in many. The authors believe that there is too great a tendency in ophthalmology to deny the benefit of surgical intervention to these patients. They state that many of them can be helped materially, and that with careful diagnosis, orthophoria can be achieved for many in the primary position, and binocularity in most of the field of vision.

## 26-1

Cook, Raymond C., and Glasscock, R. E.: *Refraction and ocular findings in the newborn,* Am. J. Ophth., 34:1407-1413 (Oct.) 1951.

One thousand eyes were studied under atropine cycloplegia; of these 74.9 per cent had hyperopia ranging from less than 1 diopter to 12 diopters; 50 per cent had less than 3 diopters of hyperopia, and 25.1 per cent had myopia ranging from 1 diopter to 12 diopters. Of this group 88 per cent took less than 4 diopters of correction. Astigmatism was present in 38.8 per cent of the hyperopic eyes and 27.3 per cent of the myopic eyes, while 4.8 per cent of the eyes had retinal hemorrhages of unknown cause usually located in or near the macular area. This may account for certain unexplained amblyopias or macular degenerations of childhood.

## 26-2

Cowan, Alfred: *Emmetropia,* Am. J. Ophth., 34:1021-1024 (July) 1951.

The refraction of an eye depends on two or more of the following: (a) the curvature of the cornea; (b) the distance from the cornea to the crystalline lens, that is the thickness of the meniscus which is the corneal system; (c) the dioptric power of the crystalline lens; (d) the indices of refraction of the optical media of the eye; (e) the distance of the fovea from the dioptric system, or the length of the eyeball.

In the static eye the reciprocal of the distance of the punctum remotum or far point from the anterior principal point (R) is the measure of the refraction (r) of the eye, $r=1/R$.

When the far point of an eye during repose (a static eye) lies at infinity and R can be replaced by the symbol $\infty$ in the formula the refraction would be expressed by $1/\infty = 0$. The refraction is zero. The eye is emmetropic.

The emmetropic eye is the standard—the zero eye—in which the position of the fovea coincides with the posterior principal focus of the dioptric system.

The emmetropic eye is not necessarily of a certain length or constant power and is not to be confused with a schematic eye, which may or may not be emmetropic. It does not need to be a healthy eye; it may even be blind. The visual acuity need not be normal.

The term emmetropia is applied to one eye; it is not concerned with binocular coordination.

Data and figures are given showing how a slight difference in length of the eyeball or a change in the radius of curvature of the cornea produces a change in refraction.

Clinically, an eye is usually called emmetropic when, under cycloplegia, the visual acuity cannot be improved by any lens. The author then mentions certain allowances that must be made.

While emmetropia is the mathematically exact refraction of the eye, it is not necessarily the most desirable. Since the eyeball grows during childhood and through adolesence, hypermetropia in children is preferable to emmetropia.

"Emmetropia is a necessary and most useful term in the classification of anomalies of refraction. It indicates the zero refraction, the line from which ametropia can be measured on either side."

## 26-3

Pendse, G. S., Dan De Kar, V. M., and Bhave, L. S.: *Preliminary note on study of the refractive state, with special reference to myopia,* Arch. Ophth., 45:168 (Feb.) 1951.

A study of refraction was undertaken in a fairly homogeneous group under the auspices of the Indian Council of Medical Research. The ages of the first group of subjects ranged from 6 to 12 years. The data are based on the examination of a sample of 590 unselected school children and the heights, weights, and blood pictures were studied where possible.

The mean refraction was shown to be + 1.0 D., the mode + 1.25 D., and the standard deviation + 1.0 D. The variation of refraction showed a downward trend with age. The average refraction at 7 years was + 1.5 D. and at 13 years was + 0.5 D.

The relation of height to refraction showed a higher refraction with shorter people. Persons of subnormal heights are shown to have a higher, (more hypermetropic) refraction than taller people. In a small series of subjects with pathologic myopia the same observation was established. The heights of these myopes are greater than the average for their age. The actual weights here were lower than the average.

Blood pictures seem to show a difference in values for serum calcium between pathologic subjects and others.

The authors conclude from the present evidence the factor of nutrition is secondary to bodily growth in the development of pathologic myopia.

## 26-4

Schlossman, Abraham: *Refraction for binocular comfort,* Eye, Ear, Nose & Throat Monthly, 30:533-536 (Oct.) 1951.

The author feels that the ophthalmologist can achieve the best results in refraction if he properly balances the objective and subjective technics. In this way the patient will receive the greatest amount of binocular comfort with the best vision.

A good refractionist should be so familiar with all the technics of refraction that he can use the one that best suits the immediate situation. The author believes that the best objective method available is the streak retinoscope, as it can be used with children and patients with language difficulties. He explains the technics of fogging and cross cylinder,

Duochrome test, binocular manifest refraction, and the use of spherical equivalent for patients who wear cylindrical correction with part or alltime wearing of glasses.

A child with concomitant convergent strabismus is usually given his full atropine correction, but if he will not accept the full correction then he should be given less plus than was measured under atropine and it should be the maximum correction that he will wear comfortably.

## 28-1

Chandler, Paul A.: *Practical considerations concerning choice of operation in convergent squint,* Am. J. Ophth., 34:375-381 (March) 1951.

A correct analysis of overacting or underacting muscles plays an important role in the choice of surgery. Equally important are the preliminary factors such as the determination of an alternating or monocular squint, the presence of amblyopia, and the refractive error.

Surgery is usually done on the squinting eye in monocular squint. A recession of the internal rectus, a resection of the external, or a combination of the two may be done. The internal rectus should be recessed if the near point of convergence is unlimited. If on the other hand the patient has a remote near point of convergence a resection of one or both external rectus muscles should be done.

The effect of the recession should be relatively greater if the following points are found: (1) the angle of deviation is greater for near than for distance; (2) the presence of a considerable accommodative element and (3) the muscle is found to be strong or abnormal check ligaments are found.

In alternating squint the following factors should be considered before surgery is attempted:

1. Patients with a hypermetropia of one diopter or more should be given a trial with glasses for at least a few months.

2. The near point of convergence is taken and if found to be unlimited with both eyes open, the test is repeated covering one eye and then repeated with the other eye covered. The examiner observes the screened eye, if the eye under cover ceases to converge at a greater distance from the root of the nose than does the other eye under cover, this may indicate that one medial rectus is stronger than the other though dominance may affect the result in some cases.

3. Whether or not the squint is greater fixing with one eye than the other.

4. The presence or absence of limitation of abduction and comparative abduction power of the lateral rectus muscles. The rotations are tested binocularly and monocularly. If lateral excursions are full but nystagmoid movements occur it may indicate a weak lateral rectus muscle.

5. The angle is determined by prism and cover test for distance and near.

6. Presence or absence of a vertical component.

7. Changes of fixation in various positions of gaze.

From an analysis based on these points alternating squint is divided into four general groups. The author describes each group thoroughly.

1. Those with an apparent overaction of the medial recti. The majority of alternating convergent squints fall in this group.

2. Underaction of the lateral recti with little or no secondary contracture of the medial recti.

3. Underaction of the lateral recti with contracture of the medial recti.

4. Overaction of the medial recti combined with underaction of the lateral recti.

## 28-3

Gibson, Glen Gregory: *Surgical principles of concomitant strabismus,* Am. J. Ophth., 34:1431-1437 (Oct.) 1951.

A plea for a systematic plan for muscle surgery in which the patients are divided into two groups depending on their sensory possibilities is made. The choice of muscles, the time of operation and the kind of operation are selected on the basis of the sensory possibilities with a plea for early surgery in most instances.

Symmetrical surgery is indicated for symmetrical findings and unilateral surgery for unilateral findings. The time of surgery is based on the principles of reflex development in childhood, age of onset, and duration of squint. Selection of various types of procedures is secondary to importance of selecting the proper muscle, time, and amount of operative correction. Marginal myotomy and graduated amounts of operative treatments are discussed. High hyperopia and a remote near point of convergence are signals for conservatism. Excessive action of internal recti or presence of muscular contracture indicates need for more than the average amount of cor-

rection. Amblyopia and anomalous retinal correspondence present additional problems.

Review of cases found 80 per cent cosmetic cures in all cases, 30 per cent functional cures in the early cases, and 10 per cent functional cures in the late cases. The final position was dependent on sensory development before onset of the deviation and length of time the deviation was present.

## 28-4

Steiner, Albert A.: *Traumatic disinsertion of the inferior rectus muscle,* Am. J. Ophth., 34:100 (Jan.) 1951.

A brief review of the rare condition of traumatic disinsertion of the inferior rectus is given. An interesting case in which the above condition existed for eight years is reported. Binocular single vision was restored with surgery and immediate postoperative biweekly orthoptic training.

## 28-5

Stine, George T.: *The surgical treatment of esophoria,* Am. J. Ophth., 34:1307-1313 (Sept.) 1951.

The author presents the results of the surgical treatment of 15 cases of esophoria, (ranging in age from 7 to 48 years) with symptoms not relieved by ordinary methods. Eight patients were male and seven were female.

Prior to operation the average esophoria was 15.5 prism diopters at 20 feet and 18.6 prism diopters at 13 inches. Two of the patients had intermittent esotropia.

In all but one case a full recession of one medial rectus muscle under general anesthesia was done. One case had both medial recti recessed, but interestingly enough was not overcorrected. Of the 15 cases reported, there was only one case of overcorrection and that one not too serious.

It seems significant that in 10 of the cases (66 per cent) there were anatomic anomalies varying from a thickening of the intermuscular membrane to secondary foot-plate type of insertions and many heavy check ligaments.

The average amount of correction obtained was 13.6 prism diopters at 20 feet and 16.1 prism diopters at 13 inches. The above results "are quite similar to results reported when exophoria is treated by bilateral recession of the lateral recti; that is, that the amount of the correction is proportional to the amount of the original deviation" not to the amount of surgery. This was demonstrated by Scobee and means, if carried to its extreme, that if two patients are seen, one with 20 prism diopters of esophoria and one with 10 prism diopters, and the same operation is done on both, the results would be that both would be orthophoric. At least the general principle seems to be true, even though this ideal condition is not always realized.

The results were most gratifying and all but two patients were asymptomatic.

The author summarizes the whole theory by saying that "esotropia is a result of hypertonicity of the convergence center frequently encouraged by anomalies of the medial rectus muscles, and that this condition can be corrected by removing the anatomic defects and decreasing the effective force of the medial rectus muscle by changing its insertion."

## 30-1

Green, Earl L., and Scobee, Richard G.: *Position of the Risley prism in the Maddox-rod test,* Am. J. Ophth., 34: 211-217 (Feb.) 1951.

A study to try to determine if a standard of testing a case of heterophoria is necessary in order to evaluate it more accurately. Cases were measured by two methods, so each case was a check on itself.

1. Maddox rod and Risley prism before the right eye.

2. Maddox rod before the right eye and Risley prism before the left eye.

A group of 51 patients were tested and it was found that the method made little difference in the measurement of lateral heterophoria, either at 20 feet or 13 inches. The vertical measurements did show a difference, thus indicating that a standard test is needed when a group of ophthalmologists are examining.

## 30-2

Kadesky, David: *A linear light target for diplopia field tests,* Am. J. Ophth., 34:756-757 (May) 1951.

The author feels that this light has distinct advantages over a point source of light.

1. A small amount of diplopia which might be interpreted as a blur with a point source of light will show as true diplopia with a linear light test object.

2. By changing the axis of a linear light source, discrimination of vertical and horizontal deviations is facilitated.

3. The presence of torsion of a linear image will immediately be apparent.

It may also be used with the red-glass test for plotting routine diplopia fields or with the Maddox double prism if torsional defects are suspected.

The light consists of a pocket flashlight equipped with No. 222 Mazda condensing globe and a lucite rod encased in a metal tube. This instrument is made by the Parsons Optical Laboratories, Inc., San Francisco, Calif.

## 30-3

Sloan, Louise L., and Rowland, William M.: *Comparison of ortho-rater and sight-screener tests of heterophoria with standard clinical tests,* Am. J. Ophth., 34:1363-1375 (Oct.) 1951.

This paper is part of a study of the reliability and validity of measures of visual functions provided by instruments such as the ortho-rater and sight-screener, and evaluates these tests in so far as they determine fitness for a particular occupation. A description of the tests is given, and the procedure outlined. A statistical analysis of the results is also presented.

## 30-4

Brockhurst, Robert J., and Lion, Kurt S.: *Analysis of ocular movements by means of an electrical method,* Arch. Ophth., 46:311-314 (Sept.) 1951.

The article explained the way of recording ocular movements by means of an electrical method. Two very interesting facts are that (1) preceding each eye movement is found a short movement in the reverse direction and (2) movements from the center to the periphery are slower than those toward the center.

## 30-5

Lion, Kurt S., and Brockhurst, Robert J.: *Study of ocular movements under stress,* Arch. Ophth., 46:315-318 (Sept.) 1951.

The article tells how the eye is put to stress by watching, alternately, two flashing lights 90 degrees apart. The test is halted when the subject can go on no longer. This test measures by the electronic method the acceleration of the eyeball, which is proportional to the muscular force which causes the eye movement.

## 33-1

Hewitt, Robert S.: *Innervational factors concerning the vertically acting extraocular muscles,* Am. J. Ophth., 34:597-604 (April) 1951.

In this paper a principle has been presented as to how the vertically acting muscles function for any ocular movement or position of the globe and some experimental evidence to support the validity of such a principle.

This principle provides (1) for a constant ratio of innervation between the superior rectus and the inferior oblique muscles; (2) for a constant ratio of innervation between the inferior rectus and the superior oblique muscles (with a normally functioning neuromuscular mechanism both of these ratios are approximately 2:1); (3) for true antagonists among the vertically acting muscles; (4) for the principle of reciprocal innervation to function with regard to the vertically acting muscles. It presents an explanation for a straight up or down movement from the primary position without additional action by the lateral rectus muscle, as well as an explanation for the torsion that occurs when the eye is in an oblique position.

It is the author's belief that the application of this principle will be found helpful in the understanding and management of vertical muscle imbalance.

## 33-2

Urist, Martin J.: *Horizontal squint with secondary vertical deviations,* Arch. Ophth., 46:245-267 (Sept.) 1951.

Dissociation of normal eyes for any period of time reveals vertical deviations are just as prevalent as lateral deviations. In a series of 615 patients with horizontal strabismus whose deviations were measured by prism and cover test, 431 or 79 per cent showed a vertical component.

A careful study of the versional movements was made. Changes were noticed in the horizontal angle of squint in certain cases of esotropias and exotropias as the patient followed the light straight up and down. The term "elevation or depression in adduction" was used to describe this condition.

In the study of the versional movement with a quantitative study of these movements with prism and cover in all positions of gaze it was found that the combination of horizontal with a vertical component was found quite frequently.

The study led to the following classification:

1. Esotropia with bilateral elevation in adduction.
   a. Marked elevation of the adducted eye on lateral movement to the right or left.
   b. On versions in the vertical direction there was found more esotropia when looking down than up.
   c. More esotropia for near than distance.
   d. Good near point of convergence.
   e. Left hypertropia greatest looking up and to the right and a right hypertropia greatest up and to the left.
2. Esotropia with bilateral depression in adduction.
   a. Depression of the adducted eye on lateral movement to the right or left.
   b. More esotropia for distance than for near.
   c. More esotropia when looking up than on looking down.
   d. Elevation of right eye on gaze to the right and elevation of left eye on gaze to the left.
   e. Near point of convergence varies from good to fair.
3. Exotropia with bilateral elevation in adduction.
   a. Elevation of the adducted eye on lateral movement to the right or to the left.
   b. Exotropia was greater for distance than for near.
   c. Exotropia looking up and a smaller exotropia on looking down.
   d. Patients screened a left hypertropia on gaze to the right, greatest up and a right hypertropia on gaze to the left, greatest up.
   e. Near point of convergence good.
4. Exotropia with bilateral depression in adduction.
   a. Depression of adducted eye (relative elevation of the abducted eye) on lateral movements.
   b. Larger exotropia for near than for distance.
   c. Exotropia greater on looking down rather than up.
   d. Patients screened a right hypertropia on looking to the right and a left hypertropia on looking to the left.
   e. Near point of convergence is usually poor.

The study of the straight up and straight down position also gives one an idea of the binocular status of the eyes. If the eyes are straight in one of these positions, fusional amplitudes could be developed. Orthoptic exercises are started in the position where the eyes are straight.

The evidence that vertical deviations are secondary to the lateral squint are based on: (1) patients with secondary deviations do not have torticollis and are able to fuse large vertical deviations, this would be rare in a case of primary vertical paralysis, (2) patients can have straight eyes yet when the eyes are dissociated, they have horizontal deviations with large vertical components, (3) the cases studied all showed a smaller vertical measurement than those of the horizontal squint and (4) correct surgery on the lateral muscles helps to improve the vertical deviation.

If the lateral squint is taken care of by glasses, orthoptics or surgery, one will find that the vertical deviation will be much improved or will disappear completely.

## 34-1

Low, Frank: *Peripheral visual acuity,* Arch. Ophth., 45:80-99 (Jan.) 1951.

It is recognized that no single investigation has ever controlled all the factors known to affect peripheral visual acuity. After further study in this field, Dr. Low concludes that all available evidence indicates that the characteristics of peripheral visual acuity have a counterpart in central acuity. Such factors as (1) effect of angular eccentricity, (2) effect of differences in meridional acuity, (3) effect of test object differences, (4) effect of brightness, (5) magnitude of individual differences, (6) effect of practice, (7) effect of spontaneous fluctuation, (8) effect of refractive conditions, (9) effect of color, (10) effect of limitation of viewing time, (11) effect of movement, (12) effect of psychological factors, and (13) effect of other factors, though especially pertinent to central acuity, nevertheless bear the same essential relationship to each other and to acuity itself in the periphery. It appears that the differences between peripheral visual acuity and central visual acuity are quantitative, rather than qualitative.

## 34-2

Raiford, Morgan B.: *Aids for determining visual acuity,* Am. J. Ophth., 34:892-893 (June) 1951.

A variation of the "E" game and a description of a new type stick pointer are presented.

## 34-3

Sloan, Louise L.: *Measurement of visual acuity: A critical review,* Arch. Ophth., 45:704-725 (June) 1951.

Dr. Sloan has investigated the relative merits of different test objects and procedures used to measure visual acuity and their use as screening tests for the detection of errors of refraction or other visual defects.

The tests of acuity used by ophthalmologists, optometrists, and in the military services are designed to detect impairment of acuity caused in a large number of cases by errors of refraction. By using the simpler test objects, patients with astigmatic errors may show a better visual acuity. For example, a patient with a simple hypermetropic astigmatism at axis 180 degrees can focus vertical and horizontal contours and, therefore, may have no difficulty with the Snellen E. The ideal test object should contain horizontal, vertical, oblique and curved contours so that it can be recognized only when clearly focused in all meridians.

The test characters should be of "a complicated form as is clinically convenient in order to subject the eye to a test comparable with varied tasks imposed upon it in every day life and yet the questions and answers should be simple enough."

"It is suggested that familiar nonserif letters be used to measure visual acuity and that about 10 such letters be selected which by experiment are found not to differ markedly in legibility. If this same group of letters is used on each line of the acuity chart, the average difficulty of each line as a whole will vary only with the size of its letters."

In the measurement of individual differences in acuity, some standard luminance of background must be adopted. The standard adopted should approximate that encountered in the use of the eyes under ordinary conditions. If the contrast is at least 84 per cent and if the background luminance is between 12 to 18 foot-lamberts, variations in contrast and in luminance of background will have a negligible effect on acuity.

Visual acuity measured at 6 meters provides a valid index of acuity at all greater distances. In special cases measurement of visual acuity may be taken nearer representative of typical working conditions.

The visual acuity of each eye should be determined with occlusion of the other eye. In many cases visual acuity is higher with occlusion than without. Since the two eyes cannot accommodate unequally, in binocular vision the amount of accommodation will probably be that required by the dominant eye if the hypermetropia is greater in one eye.

In cases where a patient's occupation requires a high degree of binocular depth perception supplementary tests of depth perception may be used to evaluate the efficiency of binocular vision. In such cases the refractive correction of the two eyes should be balanced.

## 28-2

Fink, Walter H.: *Surgery of the oblique muscles of the eye,* St. Louis, C. V. Mosby Co., 1951, as reviewed in Arch. Ophth., 46:713-714 (Dec.) 1951.

This volume about the surgery of the oblique muscles is divided into two parts. The first part deals with anatomy only and is fully illustrated. It gives the reader a clear picture of the intricacies of the relationships of these muscles and the structures to be encountered when operating. The second part deals with the physiology of the muscles and the diagnosis of the defects.

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